SCIENCE

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THE FORTHCOMING SITUATION IN AGRICULTURAL WORK[1]

THE American Association for the Advancement of Science represents the recognized and organized sciences. One by one new groups have been added to it, as those groups have won public recognition and have demonstrated that they are interested broadly in the enlargement of human knowledge. Half the letters of the alphabet are required to designate these groups represented in organized sections, indicating the breadth and vitality of our scientific inquiry. The last of these sections is agriculture—not the occupation agriculture, but the assembly of scientific research that deals with the problems of the occupation and of the living resulting from the occupation. We begin the work of this section to-day. It means much, I think, for this work that it has now been recognized as worthy to occupy a place on the programs with the older and the better standardized groups. I hope that we shall be worthy of the fellowship; and I trust that the Association itself will gain something by what we and our successors may bring to it in the future.

There is no field of scientific research that belongs exclusively to agriculture and not to other groups. The peculiarity of the research in this field lies in its association for the purpose of improving a great industry and of making a particular contribution thereby to the national life. The

[1] Address of the Vice-president and Chairman of Section L, American Association for the Advancement of Science, Philadelphia, December, 1915.

problems may be physical, chemical, biological, meteorological, mechanical, economic, social and otherwise; and therefore they are in themselves historically worthy the recognition of men and women engaged in public and scientific work. Nor are they contaminated by contact with the earth, seeing that they come out of the earth; nor again by contact with men who work, seeing that men are useful and worthy when they work.

And yet, by common consent and in the process of evolution, there is a field that is known as agricultural science. It would be vain for me to define it; probably I should succeed only to confine it. You shall learn what it is as the programs of Section M are placed before you in the succeeding years. This year, aside from the required address of the vice-president, the program considers some of the problems of economics as related specially to agriculture; those subjects are underlying, and the addresses will be interesting and important.

The subject of the symposium of this section suggests the general line of effort that Section M may profitably pursue. The section will not find it to its advantage, I think, to discuss the technical problems of the production of crops and animals. It will rather devote itself to questions that relate agriculture to public welfare and to problems of general interest, dealing with policies and the large social, economic, educational and political results. It is important that the attitude of all the sciences be brought to bear on these questions, and I look for the greatest usefulness for Section M in bringing together the agricultural work with the other work of the association. I hope that as time goes on there may be joint discussions of Section M with other sections or groups represented in the Convocation Week. Such discussions should result in much mutual advantage.

The agricultural situation is now much in the public mind. It is widely discussed in the press, which shows that it has news value. Much of this value is merely of superficial and temporary interest. Much of it represents a desire to try new remedies for old ills. Many of these remedies will not work. We must be prepared for some loss of public interest in them as time goes on. We are now in a publicity stage of our rural development. It would seem that the news-gathering and some other agencies discover these movements after the work of many constructive spirits has set them going and has laid real foundations; and not these foundations, but only detached items of passing interest, may be known of any large part of the public. I hope that we shall not be disturbed by this circumstance nor let it interfere with good work, however much we may deplore the false expectations that may result.

It has been my privilege for one third of a century to have known rather closely many of the men and women who have been instrumental in bringing the rural problem to its present stage of advancement. They have been public-minded, able, far-seeing men and women, and they have rendered an unmeasurable service. The rural movement has been brought to its present state without any demand for special privilege, without bolstering by factitious legislation, and to a remarkable degree without self-seeking. It is based in a real regard for the welfare of all the people, rather than for rural people exclusively.

Great public-service institutions have been founded in the rural movement. The United States Department of Agriculture has grown to be one of the notable governmental establishments of the world, extend-

ing itself to a multitude of interests and operating with remarkable effectiveness. The chain of colleges of agriculture and experiment stations, generously cooperative between nation and state, is unlike any other development anywhere, meaning more, I think, for the future welfare and peace of the people than any one of us yet foresees. There is the finest fraternalism, and yet without clannishness, between these great agencies, setting a good example in public service. And to these agencies we are to add the state departments of agriculture, the work of private endowments, although yet in its infancy, the growing and very desirable contact with the rural field of many institutions of learning. All these agencies comprise a distinctly modern phase of public activity.

Now, the problem is to relate all this work to the development of a democracy. I am not thinking so much of the development of a form of government as of a real democratic expression on the part of the people. Agriculture is our bottom industry. As we organize its affairs, so to a great degree shall we secure the results in society in general.

I desire to discuss certain questions that bear somewhat on this underlying problem. I shall approach these questions mostly from the point of view of our present public-service institutions for agriculture, leaving the other or non-public phases of the problem for consideration one year hence. I do not presume to make specifications for the institutions; but the questions may be discussed and perhaps we can do something to protect the institutions from demands that should not be made of them. Perhaps you will make some mental applications of the discussion to other public work than that which is specially agricultural.

It is auspicious, and perhaps it is fortunate, that this new section comes into being at a time when a vast new organized movement in the interest of agriculture is taking hold of this country. This movement is connected very intimately with government, and therefore with policies affecting all the people; and it is possible, even in a democracy, that such a trend, or even such a formalizing, may arise in the beginning as can not be greatly modified, or much changed if change should be necessary, in any number of years. You know that I refer to the Agricultural Extension Act which was signed by President Wilson on the eighth of last May. No such national plan on such a scale has ever been attempted; and it almost staggers one when one even partly comprehends the tremendous consequences that in all likelihood will come of it. The significance of it is not yet grasped by the great body of the people.

We are at the parting of the ways. For years without number—for years that run into the centuries when men have slaughtered each other on many fields thinking that they were on the fields of honor, when many awful despotisms have ground men into the dust, the despotisms thinking themselves divine—for all these years there have been men on the land trying to see the light, trying to make mankind hear, hoping but never realizing. They have been the pawns on the great battlefields, men taken out of the peasantries to be hurled against other men they did not know and for no rewards except further enslavement. They may even have been developed to a high degree of manual or technical skill that they might the better support governments to make conquests. They have been on the bottom, upholding the whole superstructure and pressed into the earth by the weight of it. When the

final history is written, the lot of the man on the land will be the saddest chapter.

But in the nineteenth century, the man at the bottom began really to be recognized politically. This recognition is of two kinds, the use that a government can make in its own interest of a highly efficient husbandry, and the desire to give the husbandman full opportunity and full justice. I hope that in these times the latter motive always prevails. It is the only course of safety.

We have developed the institutions on public funds to train the farmer and to give him voice. These institutions are of vast importance in the founding of a people. The folk are to be developed in themselves rather than by class legislation, or by favor of government, or by any attitude of benevolence from without. And now, the great extension law, for which so many men and women have worked so long, is a fact, and means are to be provided whereby the farmer may find help at his own door. A new agency in the world has now received the sanction of the people, and we are just beginning to organize it.

It is a noble expression of confidence in the persons who have prepared the people for this departure, that the legislation should have been so generous and so complete.

The days of our propaganda are passed. No longer are we agricultural crusaders, seeking to get a hearing with the powers that control, making the work felt in the nation, energizing the farming people to express themselves. I fear that this changed relation is not understood by some persons; and hereupon we come to a crucial and perhaps to a dangerous situation. Some of us have not expected the recognition to come so soon or so completely, and it may be difficult for us to understand what has happened or to readjust our activities.

There are three phases of the situation that seem to call for special consideration at this turn in affairs, one of which has no novelty, and the second and third of which appear not to have received sufficient attention.

I. THE NECESSITY OF FUNDAMENTAL KNOWLEDGE

Although there has necessarily been something of the effort at conversion, the country-life movement is not a propaganda. It is the expression of a rapidly crystallizing desire to make rural life all that it is capable to become, and to understand and to utilize in the best way all the natural products of the earth.

All this requires knowledge; and knowledge of this kind demands careful inquiry. There must be a certain relation or equation between the research effort and the teaching effort. The enlargement of one ought to be conditioned on the enlargement of the other; and certainly we ought to know before we teach. I hope that the new extension work will demand a great stimulation of research. No subject makes great headway, no people makes great progress, unless it rests on investigation and discovery and feels the stimulation of exploration in fresh fields.

Particularly do we need the balance and the check in extension teaching in agriculture, where the field is so diverse, the people so numerous and so scattered, the teachers so variously trained, and the traditional errors so many. Extension work is not propaganda; it is teaching where the people are rather than where the matriculated students are; and while it may not go so deep, it must be as true and as well standardized to ascertained fact as is the other kind of teaching. The vitality of the extension teaching, as of any other teaching in natural science, will depend on the body of exact knowledge that lies behind it.

This being true, then we must see that appropriations for extension teaching in the years to come are not out of proportion to appropriations for research. I hope that we shall soon find a wide-spread expression amongst the people for a more complete endowment of fundamental investigation in subjects related to our agricultural industries.

I will digress to say that not everything is research, in agriculture or elsewhere, that happens to bear the name. Undoubtedly research, as such, has been over-glorified. There is no sanctity in research that does not inhere also in any other good and honest effort requiring equal ability. The teacher is as worthy of honor as the investigator.

Neither is research a refuge. Certain persons who bear something of a disdain for the affairs of the world are likely to be set at more or less interesting problems under the denomination of "original investigation" and "research," and "pieces of work." Here they may find shelter and protection, and a certain deference that is very conducive to peace of mind. They are supposed "to publish," whereupon their standing is established among their fellows. It may not be necessary to raise the question as to the significance of the publication or whether it reaches any result.

We are so insistent on technical accuracy that we are likely to eliminate the imagination; and without imagination no man can accomplish real research. Result is that undoubtedly we have worthy young persons in the institutions of many kinds who are practically accomplishing little beyond receiving support.

So I am thinking of research that follows a program looking toward a solution. Each of the items of such work is in itself a contribution. Not one is meaningless, and not one is made *in vacuo*. Such investigations constitute the very beginning and basis of our accomplishments. The very rapid and really significant progress accomplished in the agricultural field within recent years has been possible because of the basis of research, which has been such a conspicuous part of it. The contributions to knowledge in this deparment have been astounding in variety, remarkable in their applications to human welfare, and many of them worthy to rank with research of highest excellence in other fields. We have a notable momentum toward original inquiry of a high order in the agricultural subjects, and we should be zealous to see that it is not halted, overlooked or eclipsed. We must consider that research does not have within itself the elements of publicity, and that it must be guarded by the good opinion and the activity of such persons as frequent conventions like this.

It is not necessary to the broad results we seek that this research shall all be directly or immediately applicable to the arts of life. It does not matter if much of it remains practically unknown to the public. The effect of the accumulation of it, if it is good, will be beyond all price, establishing a foundation, providing a reservoir from which we may draw at will, giving us a sense of conquest and of power, developing a literature, and training many men whose judgment will be of the greatest value in the control of our rural affairs. Research in agriculture should look toward a solution, but not necessarily toward a definite application, although the purpose to apply does not make it any the less research or any the less worthy of respect.

Knowledge applies itself in the end. The best and the final application of it is in a new approach to the subject and a better philosophy of action. This is well illustrated in the great work of Darwin, which

we have now learned to apply in a thousand ways, because it has entered into our philosophies. So the accumulation of knowledge touching agriculture will give those who come after us a new grasp on the rural condition, a readjustment of ideas, and confidence in our ability to handle the situation. Good research, maintained continuously and without haste by the ablest men, will make its own application.

II. THE QUESTION OF PUBLICITY

Extension work in many kinds of subjects has seemed to some persons to be of the essence of publicity. This is a damaging error. We have already agreed, I hope, that it is not propaganda; nor is it publicity, or promulgation, or advertising, or exploitation. It is properly not work to be governed merely by expediency. It is educational work performed elsewhere; and as such it should have its own orderly program.

As newspaper popularity is dangerous to a person who engages in serious and productive work, so in future will a popularizing press-service publicity, under whatever name it may be called, raise against the colleges of agriculture and the experiment stations, and the extension teaching —or other similar enterprises—a presumption that it will be difficult to live down. Remember that the situation is changed. Consider also that the American is oversupplied with what is called news, and is likely to over-estimate the value of press publicity. The agricultural education work has again met the approval of the people as expressed in a piece of great legislation. It should no longer be necessary to make public sentiment.

It is said that only a certain rather small percentage of the farming people read the bulletins of the institutions, and that, therefore, there must be some means of publicity, some making over of the literature, some new agency invoked, some peptonizing of the work, that shall interest every person. The fact as to percentages may be correctly stated, but the inference is very dangerous. The colleges and stations are not engaged in the dissemination of news; they are not in the press-bureau business. They have ample means of reaching the people through their students, their staff, their publications and their visitors. They should control their own avenues of dissemination, of course giving information and advice freely whenever requested. The reaching of all the people must come about very gradually and without haste. If one fourth of the farming people are informed, there need be no fear, and the remainder will be reached by regular and natural means as soon as they are ready to profit by the work.

It is doubtful whether any great movement or benefit is understood by more than one fourth of the people; and the knowledge of it passes very much from person to person in a hundred informal ways that are not known of the newspapers. The rise of public sentiment for a better agriculture does not depend on the numbers of persons who read the experiments at the institutions.

It is much to be desired that the bulletins shall be readable. It is presumed that all publications should be readable, seeing that they are published to be read. Good English, clear and attractive composition, lucid subdivision, the elimination of unessential parts, should make a bulletin readable by any person who has an interest in the subject; and it is not necessary that it be attractive in the newspaper sense. Such publications should be circulated widely, so far as persons seem to want them, and with the purpose ultimately to reach the entire constituency; and if some

fall to the waste-basket, it must be remembered that even the best seeds may fall on stony ground. I hope that the demand among the people for a greatly popularized bulletin literature—if such demand exists—may soon cease; at all events, we need not cater to it. The essential values and also the best scientific mode of presentation should be preserved. It must be remembered that the mode of presentation has teaching value in itself; the subject-matter may have only information-value.

Other agencies than literature, particularly than news-agency literature, must be found to carry the work to the people and to apply it there. The best results will come in the localities when the people begin to organize to receive the help. The people need more than pieces of information: they need stimulation and guidance. We look on the farm-bureau movement to accomplish very much in this way, if the motive power in it is kept with the people.

The natural and rational unfolding of the work as it issues from the institution, by means of its own agencies under its own control, will in time cover the field effectively. It is a great gain when any public institution or establishment, while still serving the people feelingly in a spirit of true democracy, passes the restless fever of publicity before the restlessness becomes chronic, and lays out a plan calculated to reach the results and then lets the process work itself out.

III. THE ORGANIZATION OF THE NEW WORK

The great Extension Act brings what is essentially a new policy into American educational procedure. Only in the mechanic arts and agriculture, as they are founded on the Land-Grant Act of 1862, do we have a national system of education; but even in this case the federal supervision in the states was at first none or nominal. With the passage of subsequent acts the federal control has become more pronounced.

Undoubtedly we have profited very much as a people by the many political, educational, legal and other experiments of the different states. We now have forty-eight of these great experiment stations—the forty-eight stars on the flag—each one attempting to work out a government that shall best meet the needs of its people. We should have gained much in regularity of procedure, and perhaps in economy of funds and in what is called efficiency, if our educational system had at first been nationalized; but we should have missed much more than we now have gained. This nationalized extension work proceeding in detail in every community in the Union will raise essentially a new principle, for us, in educational policy.

It is the common assumption that if congress appropriates money, congress (or the federal government) should control all the expenditure of it. I think this is a doubtful, if, in fact, not a dangerous doctrine. The money belongs to the people, and there should be no reason why congress may not appropriate some of it back to the people. It may be expended in the people's interest quite as well by states as by the federal government. Of course it should be honestly expended and for the purposes for which it is appropriated, but these are matters of detail that ought not to be difficult to arrange. Specially do we need some centralized power for the control of delinquencies, an office that the United States Department of Agriculture has sometimes been called upon to exert with much benefit; but this is a very different matter from controlling or making the programs in the beginning. It is very important in our great experiment in

democracy that we do not lose sight of the first principle in democracy, which is to let the control of policies and affairs rest directly back on the people.

Some enterprises should be much centralized, whether in a democracy or elsewhere; an example is the postal service: this is on the business side of government. Some enterprises should be decentralized; an example is a good part of the agricultural service: this is on the educational side of government.

Whether there is any danger in our new nationalized extension work, which we are all so glad to have and from which we expect so much, I suppose not one of us knows. But for myself, I have apprehension of the tendency to make some of the agricultural work into "projects" at Washington. If we are not careful, we shall not only too much centralize the work, but we shall tie it up in perplexing red-tape, official obstacles, and bookkeeping. The merit of the projects themselves and the intentions of the officers concerned in them are not involved in what I say; I speak only of the tendency of all government to formality and to crystallization, to machine work and to arm-chair regulations; and even at the risk of a somewhat lower so-called "efficiency" I should prefer for such work as investigating and teaching in agriculture, a dispersion of the initiative and responsibility, letting the coordination and standardizing arise very much from conference and very little from arbitrary regulation.

In the course of our experience in democracy, we have developed many checks against too great centralization. I hope that we may develop the checks effectively in this new welfare work in agriculture, a desire that I am aware is also strong with many of those who are concerned in the planning of it.

Twice I have spoken as if not convinced that the present insistence on "efficiency" in government is altogether sound. That is exactly the impression I desire to convey. As the term is now commonly applied, it is not a measure of good government.

Certain phrases and certain sets of ideas gain dominance at certain times. Just now the idea of administrative efficiency is uppermost. It seems necessarily to be the controlling factor in the progress of any business or any people. Certainly, a people should be efficient; but an efficient government may not mean an efficient people—it may mean quite the contrary or even the reverse. The primary purpose of government in these days, and particularly in this country, is to educate and to develop all the people and to lead them to express themselves freely and to the full, and to partake politically. And this is what governments may not do, and this is where they may fail even when their efficiency in administration is exact. A monarchic form may be executively more efficient than a democratic form; a despotic form may be more efficient than either. The justification of a democratic form of government lies in the fact that it is a means of education.

The final test of government is not executive efficiency. Every movement and every circumstance that takes starting-power and incentive away from the people, even though it makes for exacter administration, is to be challenged. It is specially to be deplored if this loss of starting-power affects the persons who deal first-hand with the surface of the planet and with the products that come directly out of it.

If it is important that the administration of agricultural work be not overmuch centralized at Washington, it is

equally true that it should not be too much centralized in the states. I hear that persons who object strongly to federal concentration may nevertheless decline to give the counties and the communities in their own states the benefit of any useful starting-power and autonomy. In fact, I am inclined to think that here at present lies one of our greatest dangers.

A strong centralization within the state may be the most hurtful kind of concentration, for it may more vitally affect the people at home. Here the question, remember, is not the most efficient formal administration, but the best results for the people. The farm-bureau work, for example, can never produce the background results of which it is capable if it is a strongly intrenched movement pushed out from one center, as from the college of agriculture or other institution. The college may be the guiding force, but it should not remove responsibility from the people of the localities, or offer them a kind of cooperation that is only the privilege of partaking in the college enterprises. I fear that some of our so-called cooperation in public work of many kinds is little more than to allow the cooperator to approve what the official administration has done.

There is no occasion for misunderstanding here. It is exactly because I want the college of agriculture to hold and to extend its leadership that I warn you against its assuming any dictatorship. I think the situation at this moment demands special caution. The college comes into new consciousness of power. Great forces are put in its hands. There is at present more promise of great results for the people on the land than in any other movement or situation within my recollection. It is just the moment to give the people in the neighborhoods all the freedom and all the responsibility they ought to have for their own best development. The future will care very little for the mechanism of administration, but it will care very much for the results in the training of the folk.

There is a vast political significance to all this. Sooner or later the people rebel against intrenched or bureaucratic groups. Many of you know how they resist even strongly centralized departments of public instruction, and how the effectiveness of such departments may be jeopardized and much lessened by the very perfectness of their organization; and if they were to engage in a custom of extraneous forms of news-giving in the public press, the resentment would be the greater. In our rural work, we are in danger of developing a piece of machinery founded on our fundamental industry; and if this ever comes about, we shall find the people organizing to resist it.

Of course, we want governments to be efficient with funds and in the control of affairs, but we must not overlook the larger issues. In all this new rural effort, we should maintain the spirit of team-work and of co-action, and not make the mistake of depending too much on the routine of centralized control.

In this country we are much criticized for the cost of government and for the supposed control of affairs by monopoly. The cost is undoubtedly too great, but it is the price we pay for the satisfaction of using democratic forms. As to the other disability, let us consider that society lies between two dangers—the danger of monopoly and the danger of bureaucracy. On the one side is the control of the necessities of life by commercial organization. On the other side, is the control of the necessities of life, and even of life itself, by intrenched groups that ostensibly represent the people and which it may be impossible to dislodge. Here are the

Scylla and the Charybdis between which human society must pick its devious way.

Both are evil. Of the two, monopoly may be the lesser: it may be more easily brought under control; it tends to be more progressive; it extends less far; it may be the less hateful. They are only two expressions of one thing, one possibly worse than the other. Probably there are peoples who pride themselves on more or less complete escape from monopoly who are nevertheless suffering from the most deadening bureaucracy—the insistence on mere governmental accuracy and efficiency.

Agriculture is in the foundation of the political, economic and social structure. If we can not develop starting-power in the background people, we can not maintain it elsewhere. The greatness of all this rural work is to lie in the results and not in the methods that absorb so much of our energy. If agriculture can not be democratic, then there is no democracy.

L. H. Bailey

MICROBIAL ASSOCIATIONS[1]

Sociology, as it is generally conceived, conveys a knowledge of the human as a social and ethical creature and maintains for him an harmonious relation to his social environment, as well as considers human society in its ensemble. As an individual, man's composite is different from what it is as a social factor. His attitude toward self is not his attitude toward society at large. Perhaps primitive man was concerned with self only, but with the development of society this limitation was not possible. Man, as he at present exists, has multiplied his individual and social functions. He has developed highly ethical relationships. Under existing conditions, too, he would be wholly helpless without his social ties.

[1] Address of the president, Society of American Bacteriologists.

To the biologist, this situation with man, aside from his ethical nature, may be regarded in large measure as material, biological, and may be pertinently designated as special functional development. To the human sociologist, however, the avenue of approach is through the human as a transcendent being in possession of other characteristics than material, and in no sense an animal, but a creature divested of brutish instincts. The spiritual is given command over material functioning. Biological materialism apparently yields to the enshrouding and directing forces of humanism or human ethics. Notwithstanding, the biologist feels and beholds as such a sociology of plants and animals that is very similar, and, furthermore, he sees written in their histories and associations most of the directive agencies operative in human society, only with less ethical exaltation.

This larger sociology, for such it is if we study human sociology biologically as well as through its superficial subjective manifestations, has much interest which is of useful significance. It would not be so difficult to establish parallelisms and expressions of man as an animal in every field of biology, if that were our object. This would, moreover, be a comparative study which can not occupy our attention, for it would lead us far from our purposes. The microbial world, our own province of study, offers itself for specific consideration and is of peculiar and paramount interest to a microbiologist. The possible extensive field of biological sociology just hinted at is used rather to open our minds for the possibilities contained therein.

The microbe, by itself or in pure culture, is only one phase of its existence. In company with other species quite another phase is presented, and this is determined by the associated species and by the many conditions under which these associations may be

found. Variations and multiplications in functions instituted by these associations, with the resulting products, must influence in the course of time the actual nature of the organism. Its morphology, culture and physiology must assume new aspects, for this accords, by analogy, with recognized laws of environment. If the highly developed molecular, protoplasmic complex is sensitized, some fractional group or radical thereof must yield its claim to some other of superior affinity, which in turn will manifest its presence in all probability either morphologically, culturally or functionally.

Therefore, to suggest merely the richness of a human sociology, a sociology of plants and of animals, and a sociology of microorganisms in a parallelism, fits the mind for the reception of the general principles involved and their projections into the larger field. It prepares the listener to read in fullness between the lines unwritten developments and unwritten biological laws expressed and observed in all living forms.

Humanists rightly call the social treatment sociology, but were we to mention plant and animal sociology and microbial sociology, too much may be injected for human euphony and it may be misleading. For our purposes, microbial associations are sufficiently inclusive and represent many conditions of living together. This is done advisedly, notwithstanding the common usage of the term "symbiosis," which, according to Minchin, should be applied in a restricted sense to mutual advantages on the part of each symbiont involved. Difficulties are therefore avoided by circumvention.

In Frank's treatment[2] of the biological relationships his attitude is clearly revealed by his approach and classification. His parasite depends upon another for nutrition, but the other relationships as the ivy and tree, and the mite and its hosts, as well as De Bary's[3] fungus and alga in mycetozoa, indicate only some of the more apparent biological associations. They record observations without knowledge and demonstration, without research and logical deductions. They are of the order which rank among pioneer scientific effort. Like superficial surveys, they were simply seen and recorded and have been the means of making it possible for a historical, consecutive development. Frank admitted a classification, but, laboring as he did in ignorance of the many facts which have come to light since his time, his classification seems impertinent. Others even later than this, as De Bary, Hansen, Wortmann and Berlise, would have included insects in the carrying of pollen from flower to flower, or yeasts in the starting of fermentation changes, as types of distinctive association.

Probably the first tangible knowledge of *microbial associations* may be traced to Pasteur. It may be that this "Parent of Microbiology" was not fully conscious of the significance of associations, although his work with anaerobic organisms, acetic organisms and brewing organisms must have conveyed an impression which made his mind receptive to other possibilities. There was an inference apparent in nearly all the early work—that some single species was wholly responsible for every recognized process of fermentation or disease. The emphasis thus given to pure cultures has doubtless been the means of minimizing the force and importance of mixed cultures; for has it not been a common experience of workers to witness persistent efforts in securing results by means of pure cultures

[2] A. B. Frank, *Beit. z. Biol. d. Pflanz.*, Bd. 2, S. 123, 1879.

[3] De Bary, "Comp. Morp. and Biol. of Mycetozoa and Bacteria."

from processes which were wholly complex and dependent upon an association of organisms? These intimate interrelations of microorganisms have in a degree been overlooked or neglected because of their complexity.

Garré[4] suggested that one organism may prepare the food for another by changing the medium upon which it may be growing. It is true that this had been demonstrated some years before, by Pasteur and others, but had scarcely been approached in this manner. Marshall Ward[5] added to the knowledge of the world by his studies on ginger beer. The results secured penetrated the heart of the matter and made the suspicions and facts regarding associations replete with a new meaning and value. The Japanese "sake," or rice wine, furnished an example of sequence which too extended the horizon of the nature of fermentations. The milk preparations, koumiss, kephir and many others, did not yield readily to pure culture treatment if gauged by the native products, and accordingly forced the notion of mixed cultures.

Such findings in fermentations coupled with ideas which had been advanced by botanists, as Frank, gave to bacteriological association deeper significance than had been anticipated by the earlier workers. Knowledge had progressed from loose associational relationships through the morphological to the functional aspect of association, as hinted by Garré. Now if functional, as nutrition, is to be interpreted in terms of physics and chemistry, then the basis of attack is at once affirmed. Pfeffer[6] intimated some such foundation when he advanced two classes, "Conjunctive Symbiosis," in which the functioning of one is essential to the functioning of the other—parasitism; and "Disjunctive Symbiosis," in which there is more or less independence; nevertheless, this companionship may be favorable or antagonistic. Out of these, there have apparently emerged with some definiteness "symbiosis," "metabiosis" and "antibiosis," terms familiar to every microbiologist, but not open to exact interpretation.

Pfeffer's classification provided an excellent beginning for associational studies. Whether the term "symbiosis" is satisfactory in his classification depends largely upon individual understanding. It has seemed to me that "association" would be better fitted for the place occupied by "symbiosis," and the "symbiosis" be reserved for a subclass in which a very intimate interdependable relationship exists. Apart from this, I shall follow the division of Pfeffer in our discussion.

In an effort to conform to these general classes of Pfeffer's, it is expedient to subdivide for detailed consideration, since the idea of conjunctive association branches into divers paths and disjunctive association may include many loose relationships.

Auto-relationships or those self-associations, as a class of conjunctive associations which arise from growth and multiplication, are peculiarly suggestive, for they are commonly observed in the laboratory. Organisms will flourish and grow within limitations only upon an ordinary medium, and in the natural changes as fermentations and diseases occurring outside of the laboratory, away from artificial influences, the same phenomena are observable. Buchner[7] and Carnot[8] have claimed that the cholera bacillus and tubercle bacillus find more favorable growth in cultures containing

[4] Garré, *Korrespondenzol. f. Schweiz. Aerzte.*, Bd. 17, 1887.

[5] Ward, *Philos. Trans.*, Vol. 50, 1892.

[6] Pfeffer, *Handbuch der Pflanzenphysiologie*, Leipzig, Bd. I., 1897.

[7] Buchner, *München Arztl. Intelligenzbl.*, No. 50, 1885.

[8] Carnot, *Comptes Med. Soc. de Biol.*, p. 765, 1898.

their products. On the other hand, Duclaux[9] believes that an organism becomes less vigorous when its growth is continued upon media in which some of its products exist. Thibaut,[10] LeSage[11] and Nikitinsky,[12] have studied auto-association. Their results however do not lead to the same conclusions, although they are explicable and constant. There is to be found from Thibaut a suggestion that the existence of fermentation products favors growth of yeasts. Penicillium grown on its own culture does not reach fructification, says LeSage. Then, too, Nikitinsky found favoring conditions when molds are cultivated upon media containing their own products. He noticed as well that antagonistic influences are manifested if the media contain certain carbonaceous substances, even stating that in the presence of carbonaceous foods, probably lactic acid, butyric acid and alcohol are at times responsible for stimulation or retardation. Wildier[13] has introduced the "Bios Fraga." Contrary to the views of Pasteur, he claims that minute quantities of yeast will not grow in the medium of yeast ash, ammonium salts and some sugar. He contends that the element introduced by the addition of greater amounts of yeast for inoculable material is required. He also says that it is a substance very soluble in water, dialyzable, difficult to alter or precipitate, and is found no longer after incineration. It is a substance which exists in small quantities and is indispensable. To this is attached a sort of mysticism which would lead one to recognize some hidden guard within the impregnable fortress of life.

In infectious diseases, there are indications of self-curbing or restrictive development. There appear to be some influences acting in the cases of many pathogens. For instance, the organisms which give rise to influenza, whooping cough and measles and others run their courses; they have their rise and reach their maximum stage of development, and then decline in their activity. Others, as tuberculosis and glanders, appear to be accelerated by their extended development in the body. Again, there is the type which may be designated in general by organisms which are transmitted through carriers or are commensals. Whether an organism reacts upon itself through its growth in media which are fermentable, or in the body of an animal where disease is produced, or where the body acts only as a carrier, is it not possible to discern a common functional principle responsible?

Conjunctive association seems also to designate another subclass which, for the time being, may be called "serial association." One species seems to follow upon the heels of another in point of time, and is dependent upon the other for its life and activity. Sometimes these species appear to grow together simultaneously, but in nearly every case the life and activity of the one depends in sequence upon the life and activity of the other. One seems to be the leader and the other the dependent. There are instances, perhaps, where the relationship between the two suggest an interdependence. In this case, both may be leaders and both dependents. I do not know of a case that has been worked out in detail confirming this peculiar relationship, although observation may suggest it. It may be assumed that in such a case products which are favorable to each are

[9] Duclaux, *Traite de Microbiologie,* Paris, I. and III., 1898 et 1900.

[10] Thibaut, *Cent. f. Bakt.,* Ab. II., Bd. 9, S. 743, 1902.

[11] LeSage, *Travaux scientifiques de l'Université de Reimes,* I., p. 171, 1902.

[12] Nikitinsky, *Jahrb. wiss. Bot.,* 1904, Bd. 40, S. 1.

[13] Wildier, *Le Cellule,* T. 18, p. 313, 1901.

simultaneously created. Where one follows the other, relying upon association products, many illustrations are available.

Ammonification in the soil usually asserts that protein material has undergone change, yielding a series of products by the action of specific classes of organisms. It is known that sometimes in this series more than one class of organisms is involved. After ammonia is produced, the common oxidation processes resulting in nitrites and nitrates are effected by two distinct classes. Accordingly, in the disintegration of a protein molecule by microorganisms, there are probably several classes involved in the process, each in consecutive order. All of them are dependent one upon the other in the various steps of the degradation of the molecule. Then again, if we were to consider the reduction of nitrates to nitrites to nitrogen or ammonium, there are two or three other classes, each waiting its turn in the serial change.

The different stages in the ordinary decomposition of milk speak of this same dependence. At first the several types in milk appear to foster the development of the lactic organisms; following in the wake of the lactic organisms are those which neutralize and then those which cause proteolytic changes; and if we were to trace out the reduction of the complex substances to the various simple mineral constituents that may be found in the final product, there would doubtless be other classes, similar to those found in the mineralizing actions of the soil.

In fermentations, too, are well-known examples: the change of apple must to apple wine, from apple wine to vinegar by yeast and acetic bacteria; the production of ginger beer with a specific yeast and specific bacterium; the making of "Sake" from rice by means of a mold and a yeast; as well as other well-known fermentations in nature, all of which confirm how frequently the life of one organism is dependent upon the life of another. Among the pathogens and those organisms associated with the animal body are many striking instances. The many complications illustrate the possibilities of interdependence—sepsis following scarlet fever and typhoid fever, diphtheria and pest; pneumonia following influenza and tuberculosis; gangrene streptococci with certain anaerobic putrefying organisms; pyogenic bacteria and tetanus organisms. We can not be as certain perhaps and as distinctly satisfied as in the fermentations, the nature of which is so well known, that one product follows another and definitely in the order mentioned, but that there is a decided influence manifest can not be gainsaid. When growing together under circumstances of association, the disease is usually aggravated, or one organism appears to pave the way for another. It is a kind of serial relationship which parallels very closely, to say the least, those which we find in fermentations.

This serial dependence is not lost even where host and parasite are concerned. The tick and the cow are indispensable to the piroplasma in the corpuscle; the fly and the antelope to the trypanosoma in sleeping sickness; the mosquito and man to the plasmodium in malaria; the bacterial forms and man to the ameba in his intestines; the rabbit and some outside habitat to the coccidium. The microorganisms involved in these cases are apparently dependent upon the metazoa concerned for their growth and cyclic development, very much as the nitric organisms are dependent upon the products produced by the serial changes in the breaking down of the protein molecules. In these cases in which animals furnish the material for the life of microorganisms, difficulties are found in the determination of the required condi-

tions and immunity factors of the animal, because of the limitations in knowledge. Is it not fair to suppose, however, that this required material may be just as definite, and may occupy in many cases the same relationship to the organism as in the case of fermentation?

Going a little higher in the scale of life for a single illustration, Keeble[14] contributes an interesting study of association in *Convoluta roscoffensis.*

> In its earlier youth *Convoluta roscoffensis* feeds after the manner of animals in general, on other plants and animals. This is the first stage. In the course thereof green cells appear in the body, increase, multiply, photo-synthesize and distribute food material to the animal tissues. For a while, *Convoluta roscoffensis* receives food from two sources—from ingested plants and animals and from its green cells. This second phase is succeeded by a third in which *Convoluta roscoffensis,* having ceased to ingest solid food, is nourished in the same manner as the colorless non-chlorophyllous tissues of a green plant are nourished, by the products of the photosynthetic activity of its green cells. The last stage of all which ends this strange eventful history: The animal digests its green cells, and having done so dies. In the first phase the mode of nutrition is animal-wise; in the second, part animal, part plant-wise; in the third, altogether plant-wise or holophytic, and in the fourth auto-trophic, that is by living on itself.

Interesting cases of animals and plants higher in the scale than microorganisms can be easily multiplied.

The strenuous efforts of the laboratory worker to find a medium for pure culture studies seem to be provided in nature for many organisms. What appears laborious and complex to us in our artificial attempts is simple and direct as a natural process. Oftentimes associated products suggest the missing compound for pure culture operations, as has been experienced so often, but this frequently fails quantitatively or qualitatively through some neglected or undiscovered by-product.

In Pfeffer's disjunctive symbiosis many possibilities exist, but whether they may be regarded as a true biological association, or by analysis may be included in his conjunctive symbiosis, remains an open question.

Keeble's plant animals can be regarded as independent in a sense, but, on the other hand, they are very dependent. So too, the poled lima bean needs support which may in no manner be considered a part of its metabolism. For its best development the ivy needs a tree or stone wall; still, they are not biologically related. Because a streptococcus may accompany diphtheria infections and produce complications, or the tetanus organism is found in pyogenic processes, it does not follow that diphtheria is dependent upon streptococci or that the pyogenic organisms are dependent upon tetanus organisms, to appear in the pure individual life. That these processes may be modified or that these organisms of diphtheria and tetanus are perhaps fostered by association, will not be contradicted; yet they may live as independent forms. The pertinency of this class, therefore, must find its answer in physiological dependency or social independence with favoring or antagonistic elements.

If associations of microorganisms dependent or otherwise are subjected to analysis, there may be traced through them all some functional factor or principle as temperature, oxygen supply, food supply or condition of food (whether acid or alkaline, whether dry or moist, whether composed of one class of elements or another), or the production of metabolic products. For instance, the oxygen requirements may be illustrated by the growth of *Clostridium butyricum* in the presence of aerobic organisms; moisture by the elimination of many

[14] Keeble, F., "Plant-Animals—A Study of Symbiosis," Cambridge Press.

bacteria in a mixed culture composed of brine, and the persistence of cocci and torulæ; food by the feeding of ameba bacterially or acetic organisms with alcohol; reaction by the development of the lactic organisms in milk and the eradication of its associates; temperature by a combination in the growth of tubercle bacilli with saprophytes which will not grow at moderate temperature. Those fundamental biological requirements favor some forms of life association, while antagonizing others. Taken in conjunction with metabolic products as alcohol, lactic acid, acetic acid, amino-acids, ammonium, toxins and the many others that are possible, these biological factors offer a wide range of association, and at the same time determine the limitations.

Our experiences support these views, for involution forms or distorted morphology is easily traceable to one or more factors mentioned, and in the functioning processes of microorganisms how easy it is to alter the metabolic products and even the form by the addition or omission of an element. These acts have become an unconscious procedure and we do not, as a rule, make the subject one of systematic inquiry.

The association of animal and animal, or animal and plant, or plant and plant, when carried to comparatively loose social relations will in large part support this interpretation of these more intimate associations, illustrated through the channel of microorganisms. Animal life becomes adjusted to certain plants or other animal life, and is dependent upon their existence; plants depend upon animals and other plants; into which social relations enter the factors of food, temperature, and the other life conditions which apply to all living forms. Since this seems a fact so well established, and our work as microbiologists leads into the affairs of so many organisms which instigate numerous diverse changes—changes in some instances which are instituted by associational growth and which may affect their morphology, culture and physiology—it is pertinent in our researches to consider an organism in its natural microbial associations as significant as in a laboratory pure culture. Such factors should be directive for purposes of identification, study and application, since they suggest those possibilities which may be bound up in the intra- and inter-molecular relationships and reactions that dominate associations and individuals.

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Massachusetts Agricultural College,
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Dr. A. F. A. King on Mosquitoes and Malaria[1]

Much as I might wish to write of Dr. King as a personal friend, as a great teacher, as a big, broad, warm-hearted human, in all of which rôles I knew him well, it has seemed best to your committee that I should confine my consideration to the single episode in the career of this many-sided man which relates to mosquitoes and malaria.

Dr. King was a deep thinker. He was not satisfied with even the generally accepted and apparently well founded views of men of science and of his own profession without a careful consideration and an ingenious twisting and testing of argument. This quality of mind he showed in a marked degree during the years 1881 and 1882 when he was filled with the thoughts of malaria and its probable origin and transmission. He never told me how or when the idea came to him that mosquitoes were transmitters of this disease. His search of the literature probably followed a fairly well worked out argument originating in his own mind. Surely he considered the idea as original when he came, probably late in 1881, to the laboratory of the late

[1] Read at the memorial meeting for Dr. A. F. A. King of the Medical Society of the District of Columbia, Washington, January 20, 1915.

Dr. C. V. Riley, my former chief and predecessor in office, and talked over the idea with Riley and myself. Shame to the short-sightedness of the two of us, that we rather scouted the idea, while giving him the information on mosquito biology which he afterwards incorporated in paragraph No. 1 of his published brief.

His argument was fully elaborated and his full paper was prepared early in 1882 and was read before the Philosophical Society of Washington, February 10 of that year, under the title "The Prevention of Malarial Disease Illustrating *inter alia* the Conservative Function of Ague." This meeting of the Philosophical Society was attended by forty-two members and visitors, and Dr. King's paper was discussed by Dr. J. S. Billings, Professor Doolittle, Dr. Toner and Dr. Antisell. No record was made of what was said in discussion except the following:

> Mr. Billings remarked that since ague did not invariably result from insect bites, the most that could be claimed was that they accomplished an accidental inoculation with malarial poison.[2]

This statement is rather ambiguous and does not indicate what Dr. Billings really thought of Dr. King's paper.

The paper in its full form was never published, but in *The Popular Science Monthly* for September, 1883, Vol. XXIII., pages 644–658, appears an article entitled "Insects and Disease—Mosquitoes and Malaria," which in a footnote is said to have been an abstract of the Philosophical Society paper. It is upon this published abstract that the scientific world's knowledge of King's views is based. Since the discussion in Riley's office, he had made a careful study of the literature and had found references to several early suggestions as to the possible carriage of disease by insects or as to the cause of disease by insect bites. His arguments are displayed in connection with nineteen propositions or series of facts with regard to the so-called malarial poison. These facts were derived from different sources, but most of them were quoted from a paper read by Dr. John T. Metcalf, United States Sanitary Commission, 1862. Not all of these nineteen paragraphs are of equal force; and it has become the custom of writers in referring to King's paper to reduce them practically to the following:

1. The malarial season corresponds to the season of mosquito abundance.
2. Malarial country is suitable for mosquito breeding.
3. Similar conditions afford protection against malaria and against mosquitoes.
4. Exposure to night air means exposure to mosquitoes.
5. Influence of occupation. Soldiers, tramps and fishermen are particularly susceptible to malaria and are especially exposed to mosquitoes at night.
6. Turning up the soil or making excavations in previously healthy districts is often followed by malaria, but this turning up of the soil gives opportunities for water to accumulate and thus for mosquitoes to breed.
7. Coincidence of malaria and mosquito abundance—increase of both in late summer and early autumn.

But this summary gives but a faint idea of the value of *The Popular Science Monthly* paper. The reasoning throughout is close and convincing, and additional important points are brought out. For example,

> "Malaria has an affinity for dense foliage, which has the power of accumulating it when lying in the course of winds blowing from malarious localities," and mosquitoes accumulate in and are obstructed by forests and trees.

Again,

> "In proportion as countries previously malarious are cleared up and thickly settled, periodical fevers disappear."

Here he points out that in such cases the land is cultivated and its swamps and pools are drained so that mosquito-breeding places are abolished. He further states that as the forests and underbrush disappear before the implements of the agriculturist colonies of

[2] *Bulletin of the Philosophical Society of Washington*, Vol. VI. (containing the minutes of the society for the year 1883, etc.), published 1884, page 10.

mosquitoes wafted by winds are not obstructed and are accumulated by foliage. Again, the fact that malaria usually keeps near the surface of the earth and is said to "hug the ground" or "love the ground" corresponds once more to the habits of mosquitoes.

It will be unnecessary to take up any of the further points, except to quote two significant paragraphs as follows:

> In opposition to the mosquital origin of malarial disease it is known that numerous mosquito wounds may be inflicted without the occurrence of malarial disease; but this is by no means incompatible with the theory. We do not yet know whether the poison be mosquital saliva or whether the fever-producing element be a bacillus with which the puncturing proboscis of the insect may be loaded at the time of inflicting its wounds. The scratch of a lancet will not produce vaccinia unless the instrument be charged with vaccine matter; the puncture-needles of Pasteur would be harmless and impotent, did he not load them with infecting bacteria; so with dog-bites and hydrophobia, etc.

Again:

> Nay, it may even turn out that, under certain circumstances, mosquito-bites shall even be protective against malarial disease, for as Pasteur and others are able to produce, artificially, "attenuated culture-fluids," the inoculation of which, while producing slight symptoms, protects from more serious phases of disease, so may there exist in nature naturally "attenuated" fever-poison fluids, the inoculation of which, by mosquital puncture, may produce trivial symptoms, and thus protect from more decided attacks of veritable fever.

In the first of these paragraphs Dr. King fully meets the objection which curiously enough is raised to-day in the Bitter Root Valley in Montana by the inhabitants who claim to disbelieve the so-called theory of the tick-transmission of the Rocky Mountain spotted fever. "Why," they say, "We have been bitten by ticks many times and have never had the fever." As King pointed out in these early days, they have not been bitten by an *infected* tick.

In the second paragraph he almost anticipates Koch's conclusions as to the immunity of native children in German East Africa, even though he does not point out their danger as reservoirs.

It may be well to quote still another paragraph which is of especial significance:

> In so far, therefore, as regards the geographical relation between mosquitoes and malarial disease, it may be said: (1) The two often coexist; (2) there is no decided proof that localities alleged to be exempt from ague are also exempt from mosquitoes; (3) there is no locality noted for malarial disease where mosquitoes do not exist.

Very naturally, in conclusion, the far-sighted author mentions the question of prophylaxis on the basis of his theory. He points out protection to the individual during the evening and night by gauze curtains, window-screens or clothing impenetrable to their probosces, or an anointment of the body with some liniment; protection to the domicile by screens or fences, or light traps, or the use of smoke such as pyrethrum, or of a volatile oil; municipal protection by the destruction or draining of swamps and pools, etc.

It will thus be seen that malarial prophylaxis has made practically only one step since the days of King, except in so far as measures are concerned which depend upon the now known biological peculiarities of malarial species. His system included everything which was done in Italy for many years after Ross's discovery and which resulted in the lowering of the percentage of malaria on the Roman Campagna from 74 to 14, and his only omission from the present system is that of quininization of the people at large as practised by Koch in East Africa and by the late Dr. Celli and his colleagues in Italy to-day.

It is strange that so suggestive a paper as this and, in fact, one so theoretically conclusive, should have been received with so little interest and have been so soon forgotten. That Dr. King was a strong man is shown by the fact that he was not in the least discouraged by his interview with so renowned an entomologist as Riley, or by the lukewarm interest with which his original paper was received by the Philosophical Society of Wash-

ington, but went on and prepared it in its final form for publication in *The Popular Science Monthly*.

There was little published comment, and it was not until 1899, sixteen years later, that Dr. Geo. H. F. Nuttall, now of Cambridge University, England, in his classical paper "On the Rôle of Insects, Arachnids and Myriapods as Carriers in the Spread of Bacterial and Parasitic Diseases of Man and Animals—A Critical and Historical Study," published as one of the Johns Hopkins Hospital Reports, Vol. VIII., Nos. 1 and 2, that the full force of King's argument began to be appreciated. Nuttall here incorporated practically all of King's arguments and added many data gathered from other writers as well as his own, and, as he has since publicly stated and as he has personally remarked to me, it is remarkable that the 1883 paper was not soon followed by critical investigation. As has been shown so many times since, however, and strikingly in the case of Sambon's insistent claims for the carriage of pellagra by *Simulium*, a theory in no way comparing to King's for the soundness of its basis, conclusions based on epidemiological findings or upon coincidences are always dangerous. Where the range of a suspected host coincides with the range of a disease, it is possible or even probable that the suspected host may have some relation to the disease, but of course transmission experiments are necessary for absolutely definite conclusions.

And so it happened that, apparently without knowledge of King's paper, but based upon his own work in the transmission of filariasis by *Culex* and upon the then recognized transmission of the causative organism of Texas fever of cattle (sometimes called bovine malaria) by a tick as demonstrated by Smith and Kilbourne, Manson suggested to Ross the necessity for accurate laboratory work on malaria with mosquitoes as possible hosts. How triumphantly Ross carried out this magnificent piece of research is known to all the world, but it is a pity that it had not been done years earlier. Of course the laboratory technique in 1883 was not what it was in 1897, and of course, although Laveran had already discovered the *Plasmodium malariæ*, practically nothing was known of its life-cycle in 1883, but is it not possible, indeed is it not probable, that, had our fellow member, Doctor King, possessed the laboratory facilities and the technique at the time when he was so full of his great idea, he would have solved the problem, would have confirmed his anticipations, would ultimately have received the Nobel prize, and would have gone down to history as one of the greatest benefactors of the human race?

L. O. HOWARD
U. S. DEPARTMENT OF AGRICULTURE

THE COMMITTEE OF ONE HUNDRED ON SCIENTIFIC RESEARCH OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE committee held its second meeting in Houston Hall, the University of Pennsylvania, Philadelphia, on the afternoon of December 28, 1914. Mr. Pickering was in the chair, and the other members present were:

Messrs. E. W. Brown, Franz Boas, J. McK. Cattell, A. D. Cole, Edwin G. Conklin, Chas. R. Cross, Chas. B. Davenport, H. L. Fairchild, Karl E. Guthe, Ross G. Harrison, L. O. Howard, George E. Hulett, Chas. S. Howe, W. J. Humphreys, W. W. Keen, Frank R. Lillie, D. T. MacDougal, C. F. Marvin, C. L. Mees, George T. Moore, T. H. Morgan, Herbert V. Neal, Edward L. Nichols, E. B. Rosa, Wm. T. Sedgwick, Frank Schleslinger, Edgar F. Smith, Henry B. Ward and Arthur G. Webster.

After a statement by the secretary and introductory remarks by the chairman, the committee listened to reports from the subcommittees on research funds, on research in educational institutions, on the selection and training of men for research, on the promotion of appreciation of research and on plans for the subcommittee on research in industrial laboratories. Each of the reports was fully discussed, most of the members of the committee in attendance participating.

On the recommendation of the executive

committee or on motion, action was taken as follows:

1. Mr. Charles R. Cross was made chairman of the subcommittee on research funds, to fill the vacancy caused by the death of Charles Sedgwick Minot. Mr. W. B. Cannon has been appointed to fill the vacancy on the committee of one hundred.

2. The subcommittee on research in industrial laboratories was constituted to consist of Messrs. Raymond C. Bacon, C. L. Mees, M. C. Whitaker and W. R. Whitney.

3. A subcommittee on research under the national government was authorized with Mr. S. W. Stratton as chairman.

4. A subcommittee on research on the Pacific Coast was authorized with Mr. J. C. Merriam as chairman.

5. The executive committee was authorized to establish other subcommittees. Among those suggested and discussed were committees on research institutions, on research in museums, research under municipalities, research in the south, research by agencies promoting the public health and the publication of research.

6. The committee adjourned to meet with the American Association for the Advancement of Science at Columbus, Ohio, on the afternoon of Monday, December 27, 1915.

There are appended the opening remarks of the chairman of the executive committee and reports from the four subcommittees.

J. McK. Cattell,
Secretary

SCIENTIFIC RESEARCH: INTRODUCTORY REMARKS BY THE CHAIRMAN

Several persons have asked the question "What can be accomplished by the Committee of One Hundred on Scientific Research?" To answer this question, we must first ask, what is the present condition of the United States as regards scientific work of the highest grade, and what means are at present available? Six years ago from a study of the men recognized as eminent by the great scientific societies of the world, it appeared that the number selected from the United States was six, the same as from Saxony. The ratio of the populations is about twenty to one. Of the Americans thus selected no one devoted much, if any, of his time to teaching, and three were born outside of the United States.

The government of the United States expends an enormous sum each year in scientific research. In the departments of science best known to me, a portion only of this amount is spent wisely. Certain of the states and cities also appropriate large sums, a part of which may be regarded as devoted to research.

At the last meeting of this committee the results attained by the research laboratories of the great industrial corporations was brought out in a striking manner. It was shown that they were not restricted to commercial results, and that friendly relations existed between them. A single successful research might here easily repay the entire expenditure.

The universities of the country devote vast sums to the diffusion of knowledge, but their contributions to its extension are comparatively limited. They expend large sums entrusted to them with the condition that it shall be used for original research, and valuable results are also obtained by their officers in their own time. The proportion of the entire funds which is devoted to research is, however, exceedingly small. There are few universities which could appropriate money for research, apart from teaching, for instance, to supply an officer with an instrument, an assistant, or money for publication. The general public do not realize this; they think that since the universities teach science, they add to it, as well as diffuse it. Research receives but little aid from the numerous unrestricted gifts to universities. If a tenth of the money used for teaching were employed in research, Americans would soon take their proper places among the great men of science of the world.

Certain institutions like those established by Rockefeller and Carnegie have devoted large sums of money to research along particular lines, but having no especial relations with other investigators.

None of the methods so far described help the man of genius in his home or in his laboratory, none of them "seek the particular man, and aid him." The research funds are the only means for supplying these needs. Unfortunately, their total income is small, but some of them have a very remarkable history. For instance, the Elizabeth Thompson Fund has an annual income of about a thousand dollars, but largely through the eminent skill of our late fellow member, Charles S. Minot, during quarter of a century it has aided 169 researches, with only five failures. A large part of these could not have been completed without this aid. The grants have been distributed throughout

the world and have aided nearly every department of human knowledge. Similar results in a narrower field have been reached by the Rumford Fund. By such funds as these, administered by local committees, it is probable that greater advances in pure science can be obtained for a given outlay than in any other way. An attempt has been made to furnish a concrete example.

Astronomy has been more favored than any other science in receiving large gifts for its support, and it is through these that America occupies its present honorable place in astrophysics. As a consequence, observatories are carefully organized and great results can be obtained from a moderate expenditure. Recently I wrote to twelve leading astronomers, asking each how he would expend a moderate sum.[1] The unexpected reply was that, in almost every case, the greatest need was for an assistant. In many cases, a small sum would thus double the output of an observatory.

It is obvious that each of the problems here considered suggests a field of work for this committee, at first through subcommittees accumulating facts and then if possible improving the conditions. We shall this afternoon see that a good beginning has already been made.

REPORT OF THE SUBCOMMITTEE ON RESEARCH FUNDS

The fact that the members of the subcommittee on research funds reside in places remote from one another has made it impracticable since its appointment in April, 1914, to hold formal meetings, but several meetings of an informal character for consultation and debate have taken place among those who could be assembled. At only one of these, however, have they had the benefit of the counsel and advice of Dr. Minot, the chairman, since his illness followed by death occurred before any work could begin in the autumn.

It seemed to the subcommittee that a most obvious manner in which at the beginning, it could aid the work for which the Committee of One Hundred was instituted would be to enter, if possible, into communication with those having the charge of the various funds in this country which are available for purposes of scientific research, so that there might be a wider knowledge than at present exists as to the range of application of the several funds and of the researches in progress with aid from any one or more of them. With this knowledge, in case of the receipt of meritorious applications for aid by the trustees of any particular fund which they were unable to grant or which might seem to come especially within the scope of some other research fund, the trustees thus applied to could refer such applications to those in charge of such other fund should they think it advisable. With this end in view, the following letter was sent to the chairmen of the trustees or committees in charge of a number of representative research funds.

Dear Sir: At a meeting of the "Committee of One Hundred on Scientific Research" of the American Association for the Advancement of Science held at Washington, April 20, 1914, several subcommittees on Research Funds, was constituted as follows: Charles S. Minot, chairman, Simon Flexner, E. C. Pickering, R. S. Woodward, Charles R. Cross, secretary. The recent illness and death of Dr. Minot have deprived the subcommittee of his inestimable services.

It is felt that this subcommittee may perhaps aid in the furtherance of research if it can bring about relations of correspondence among those in charge of the various research funds existing in this country, whereby scientific workers who need aid in the prosecution of their researches may be directed to the sources from which such help is most likely to be obtained. This has been done informally in a number of instances in the past, and the experience thus gained has suggested the belief that some definite plan of cooperation would be useful.

For this it would be desirable that the subcommittee on research funds should have a record of the several existing funds, the amount of each, the approximate annual income from each, the objects to which they are devoted, the conditions under which they are available, and the grants already made for researches still in progress. Frequently such information is already to be found in published form. With this at hand, the committee could refer suitable applicants to the officers in charge of such particular funds as in its judgment might appropriately consider the matter.

The committee, of course, would neither expect nor desire that any portion of the authority or responsibility of the trustees of any research fund should be delegated to it. Its function would only be to act as a sort of clearing house, as it were, which could to some extent classify and distribute applications for aid to the most available sources. Such a procedure would in no way obligate the managers of any funds to grant aid to any person unless they should believe that they themselves would have been ready to do so upon their own initiative.

It seems to be the case that many younger scientific men who are engaged in the prosecution of meritorious researches are not aware of the existence of certain of the research funds, and still less of the purposes to which they may be applied. Such a committee as that appointed by the American Association for the Advancement of Science, which would soon become generally known, might, it would seem, be of value to all such.

Will you kindly inform the undersigned whether

[1] See SCIENCE, Vol. XLI., p. 82.

such suggestions as have been made in this letter meet with your approval, and whether you would be willing to join in such collaboration as has been outlined. And furthermore, if you are favorably disposed toward such action as that outlined in this letter, this committee would be glad to know whether you have at present any applications for grants for research which you care to send to it for consideration.

An early reply will be appreciated in order that as complete a report of progress as is possible may be made to the American Association at its forthcoming meeting in Philadelphia.

I am

Yours respectfully,

CHARLES R. CROSS,
Secretary of the Subcommittee on Research Funds

The replies received express approbation of the plan set forth in the letter and indicate a willingness to undertake such an intercommunication of information as the letter suggests.

CHARLES R. CROSS,
Secretary

SUBCOMMITTEE ON THE SELECTION AND TRAINING OF STUDENTS FOR RESEARCH

In presenting a report from the subcommittee on the selection and training of students for research Professor E. W. Brown regretted that owing to his absence until November very little had been done. He gave, however, a brief account of some of the ideas which the subcommittee had in mind. One of the chief questions raised has been whether the chief effort should not be made towards improving the facilities for the abler men in their undergraduate work. In two or three of the American universities special courses have been established for such men and it is proposed to find out how much development has taken place in this direction and what success has been achieved so far. The subcommittee also proposes to find out the methods used in other countries to advance the interests of the abler students. Various methods have been planned to achieve this object: amongst them separate instruction, extra work, less teaching in the classroom and more work expected outside, the recognition of scholarship in various ways and more specialization in one or two particular subjects have been suggested. In the discussion which followed some valuable suggestions were made. It was pointed out that in some subjects far too much assistance was given to the students, and consequently their faculties are not properly developed. It was proposed that some effort should be made in the direction of inducing graduate students to go to some particular university because of the excellence of the department in that university rather than on account of the money rewards which it might offer. The committee hopes to undertake investigation of these questions and to offer a report with suggestions in due time.

SUBCOMMITTEE ON RESEARCH IN EDUCATIONAL INSTITUTIONS

The chairman of the committee, Mr. Edward L. Nichols, made a report of progress. The committee had had two meetings, and through its secretary, Mr. J. McK. Cattell, had addressed letters individually written and signed to the executive heads of all institutions of higher education in the United States, some 600 in number. The letter made enquiry concerning the attitude of the institutions in the following respects: (1) In making appointments and promotions, what weight is given to scientific research and productive scholarship? (2) Is research a part of the work expected from instructors and professors, and, if so, how much of their time can be devoted to it? Replies had been received from most of the institutions and some of them were read to the committee. In general they emphasized the weight given to scientific research and productive scholarship in making appointments and promotions and stated that research work was regarded as part of the function of the institution and its instructors, but there was great variation in different institutions. The committee plans to prepare and publish an analysis of these letters. It hopes later to make enquiries in regard to the actual opportunities for research work in different institutions.

PROVISIONAL REPORT OF THE SUBCOMMITTEE ON THE PROMOTION OF APPRECIATION OF RESEARCH

Your committee believes that the main ideas which it desires to present are already familiar to those conversant with the situation. But the committee nevertheless believes that these ideas are so important as to need further reiteration and emphasis.

In the first place a marked distinction may be made between research concerning the fundamental laws, principles and phenomena of any given subject, on the one hand, and research aiming to apply these laws more efficiently to practical purposes on the other hand. Happily, research in applied science is being developed, each year in larger measure, on this side of the Atlantic. None the less, there is danger of our overlooking the first type of

investigation, which is really more important than the other, because principles can not be applied before they are understood.

Research in pure science, with which the committee is mainly concerned, may in turn be divided into two categories: first, the discovery of original ideas and new phenomena; and, secondly, the systematic elaboration of ideas already suggested. Investigation of the latter type demands, to be sure, a high quality of intellect and thoroughly competent training, or it may become worse than useless; but, given these things, its success is mainly dependent on efficient organization and adequate financial support. On the other hand, research of the former type (namely, that leading to the discovery of new ideas) demands not only intellect and training, but also initiative or genius; it can come only from an *individual*, and from an individual possessing intuition and insight far beyond those of the average man. Because of the extraordinary importance of new ideas, especial emphasis must, therefore, be laid upon finding and supporting brilliant individuals.

It is not within the province of your committee to discuss the question as to whether these would best be fostered by universities or by research institutions. Each may be of invaluable service in its own way, and it is highly probable that some men would work better in one atmosphere and others in the other. We believe, therefore, that it would be a mistake for either universities or unacademic establishments to obtain a monopoly of research.

The main point with which we are concerned is the question of finding the underrated, unusual man and seeing that he is appreciated and given opportunity in the place best fitted to develop his powers. It is probable that at present the university is the best hunting-ground for this purpose, because the investigators in our important research institutions are already well fostered. In our great American institutions of learning, much valuable research is even now being accomplished both by teachers and by students. Among these men there are certainly many who are especially worthy of additional opportunities—for, in most cases, additional opportunities are needed by the men who are to perform original work of a high order. The demands made upon the American teacher are often not too great for those whose main business it is to teach, but, both in hours of class work and of administrative routine, they are very often altogether excessive for him who ought to give his main energy to research.

We feel, therefore, that in order to encourage the original minds in America, there should be more research professorships and research assistantships of high grade, which would raise their holders above the worry and inefficiency caused by financial need. Your committee recognizes that in most, if not all, American institutions of learning the salaries of professors are too low to support adequately those who have families, and believes that the salaries should be large enough to enable the original man of high rank leading the normal life to give his whole time to research and not to be forced into pot-boiling distractions. We all know of specific cases of men of unusual ability who have reluctantly abandoned research in pure science because of legitimate financial necessity.

Moreover, the research professor should not only be given time and adequate salary, but should likewise be provided with such skilled, private assistants as he may need to bring his work to its full fruition, and should be allowed to choose from among the graduate students applying for guidance those whose ability promises to offer real service to science.

The finding of the really promising man (who must possess not only originality, but also sound judgment and intellectual honesty) is not easy, because it often involves the gift of prophecy on the part of the searcher. Nevertheless, it seems to us that all those in each of our larger institutions of learning who are really interested in research of the highest kind, either individually or grouped together as a voluntary committee, should keep their eyes open for persons possessing in high degree the happy combination of qualities desired, and should urge upon presidents and governing boards the importance of supporting these persons so as to make it possible for them to yield their best fruit in discovery. To some extent, of course, this is already done, but concerted action and greater emphasis are desirable.

We suggest also that those understanding the importance of investigation should emphasize this importance on every reasonable occasion, and endeavor to increase the appreciation of the people of America, even the cultivated section of which is often ignorant of the nature and value of scientific research. This can probably be accomplished most successfully by pointing out how much has resulted for the good of humanity from specific researches in the past, bearing in mind the profound statement of Francis Bacon: "There is much ground for hoping that there are still laid up in the womb of nature many secrets of excellent use, hav-

ing no affinity or parallelism with any thing that is now known, but lying entirely out of the beat of the imagination, which have not yet been found out. They too, no doubt, will some time or other, in the course and revolution of many ages, come to light of themselves, just as the others did; only by the method of which we are now treating they can be speedily and suddenly and simultaneously presented and anticipated.''

These suggestions constitute the recommendation of this preliminary report.

THEODORE W. RICHARDS, *Chairman*
HARVEY CUSHING,
RICHARD MACLAURIN,
T. H. MORGAN,
E. H. MOORE

SCIENTIFIC NOTES AND NEWS

THE award of the Bruce Gold Medal of the Astronomical Society of the Pacific, for 1915, has been made to Dr. W. W. Campbell, director of the Lick Observatory, "for distinguished services to astronomy." Candidates for this medal are nominated annually by the directors of the Berlin, Greenwich, Paris, Harvard, Lick and Yerkes Observatories, and from these the medalist is elected by the directors of the society.

DR. JOHN C. BRANNER has submitted his resignation as president of Stanford University to take effect on July 31.

PROFESSOR G. O. SARS, professor of zoology in the University of Christiania, has been elected an honorary member in the Challenger Society.

AT the annual exercises of the American Museum of Safety, held in New York on February 10, the following medals were awarded: The *Scientific American* medal for the most efficient safety device invented within a certain number of years and exhibited at the museum, to the Shurloc Elevator Safety Company, Inc., New York; the Travelers' Insurance Company's medal for protecting the lives and limbs of workmen, to the Commonwealth Edison Company of Chicago; the Louis Livingston Seaman medal for progress and achievement in the promotion of hygiene and the mitigation of occupational disease, to Surgeon-General William C. Gorgas, U. S. A.; the E. H. Harriman memorial medal to the American steam railroad which during the year has been the most successful in protecting the lives and health of its employees and of the public, to the New York Central Railroad; the Anthony N. Brady memorial medal to that American electric railway company which for the year of the award shall have done most to conserve the safety and health of the public and of its employees, to the Boston Elevated Railway Company.

THE National Committee on Mental Hygiene met in New York City on February 17 when officers were elected as follows: *President,* Dr. Lewellys F. Barker; *vice-presidents,* Dr. Charles W. Eliot and Dr. William H. Welch; *treasurer,* Otto T. Bannard; *medical director,* Dr. Thomas W. Salmon; *secretary,* Clifford W. Beers; *executive committee:* Dr. August Hoch, chairman; Dr. George Blumer, Miss Julia C. Lathrop, Dr. William Mabon, Dr. William L. Russell and Dr. Lewellys F. Barker. Gifts of $44,500 by Mrs. Elizabeth Milbank Anderson and $40,000 by Mrs. William K. Vanderbilt for the general work were announced, and the Rockefeller Foundation has agreed to contribute for a series of years the money necessary to retain the services of Dr. Thomas W. Salmon, who has been medical director of the national committee for three years.

DR. CHARLES D. WALCOTT, secretary of the Smithsonian Institution, has received a letter to the effect that the Stazione Zoologica at Naples is in a somewhat serious condition financially, owing to the withdrawal of German support. The Smithsonian Institution maintains a table at the station, which is all it can do under existing conditions. The writer of the letter suggests that if our universities would take up some of the vacated tables, it would not only assist the station, but would eventually result in closer cooperation between our scientific men and those of Europe.

AT the meeting of the Royal Geographical Society on January 11 the president made the following statement: "Before we come to the

business of the evening, I have a piece of news to tell you which I am sure you will be glad to hear. A very distinguished honor has been bestowed on our old friend and secretary, Dr. J. Scott Keltie. The American Geographical Society has conferred on him the Cullum gold medal, a medal which is given not annually but only on special occasions. I believe it has been given to only seven or eight people since it was founded, and amongst the holders have been Captain Scott, Dr. Nansen, Admiral Peary, and others of equal eminence. You will also be glad to hear that the council has made an arrangement by which, when Mr. Arthur Robert Hinks succeeds in March next to the posts of secretary and editor, Dr. Keltie will remain with us for another two years as joint editor of the *Journal,* and will thus be able to give his successor the help of his long experience when taking over these offices."

THE Spingarn medal of the National Association for the Advancement of Colored People, which is to be awarded annually to the man or woman of African descent and American citizenship who shall have made the highest achievement during the preceding year in any field of elevated or honorable human endeavor, was given to Dr. E. E. Just, of the Harvard University Medical School, for his work in physiology and in improving the standard of negro medical schools. The medal was presented by Governor Whitman at a meeting held in New York City on February 12.

M. ROBERT JONCKHEERE, of the University of Lille, is now at the Royal Observatory, Greenwich.

P. S. BARNHART, late assistant professor of zoology at the University of Southern California, and a member of the U. S. Fish Commission forces at Venice, California, has recently joined the staff of the Scripps Institution for Biological Research of the University of California, where he will arrange an aquarium for the exhibition of live animals and continue the development of the institution's museum of Pacific Ocean animals.

MR. B. F. GROUT, consulting engineer of Pittsburgh, who at one time was a professor in the school of mines of the University of Minnesota, has recently been engaged by the Minneapolis General Electric Company, in connection with the tests of the efficiencies of its turbines in the Coon Rapids Plant.

MR. ARTHUR G. WEIGEL, a graduate assistant in chemistry at the Massachusetts Agricultural College, has accepted a position as chemist in the Experiment Station at Stillwater, Oklahoma.

DR. HENRY S. PRITCHETT, president of the Carnegie Foundation, delivered the dedicatory address at the dedication on February 20 of the new Municipal Hospital of the city of Cincinnati.

BEFORE the Geographic Society of Chicago on February 26, a lecture will be given by Dr. Homer L. Shantz, plant physiologist, U. S. Department of Agriculture, on "The Natural Vegetation and Agriculture of the Great Plains and the Great Basin."

DR. CHARLES H. T. TOWNSEND, of Washington, D. C., delivered the principal address at the Tenth Annual Banquet of the Tompkins County Medical Society, held at Ithaca, N. Y., on February 16, his subject being "Verruga and its Transmission."

SIR W. WATSON CHEYNE delivered the Hunterian oration at the Royal College of Surgeons on February 15, his subject being "The Treatment of Wounds in War."

IN an address before the Surgical Society of Paris on February 6, Dr. Truffier is reported by the *Medical and Surgical Journal* to have said that of the 14,000 surgeons in the French army, 6,500 are now at the front. Up to the close of December 93 surgeons had been killed, 260 wounded, 440 were missing.

WE learn from *Nature* that the monument on the grave of the late Dr. Alfred Russel Wallace in the cemetery at Broadstone, Dorset, is a fine specimen of fossil tree from Portland, seven feet in height and weighing some two tons. The specimen stands on a foundation of Purbeck stone, and an inscription on

it indicates merely Dr. Wallace's name and dates of birth and death.

As we have already noted a monument has been erected at Finse, among the mountains of southern Norway, in memory of Captain Scott and his companions. We learn from the Geographical *Journal* that at the unveiling of the monument on December 28 by Dr. Skattum, vice-president of the Norwegian Geographical Society, made feeling reference to the noble characters and heroic deaths of the explorers. "Could anything," he asked, "be conceived more elevating from its grand ideality, than the conduct of Scott and his followers during their final death-march? It represented the very highest display of moral strength, the greatest possible exhibition of physical and mental fortitude and endurance." A second monument, subscribed for by Norwegian friends and admirers, and by British residents in Norway, will be erected at Fefor in Gudbrandsdalen, the place chosen by Scott for the trial of his motor sledges and other polar outfit. A memorial to Lieutenant Bowers, placed in Bombay Cathedral by his fellow-officers of the Royal Indian Marine, has also been lately unveiled, the ceremony being performed by Lord Willingdon, governor of Bombay. It is in the form of a simple tablet of marble, with an inscription quoting Captain Scott's tribute to Bowers as "cheerful, hopeful and indomitable to the end."

Dr. James J. Scannell, director of the bacteriological laboratory of the Boston Board of Health, died on February 19.

Dr. Adam Massinger, of the Heidelberg Observatory, has been killed in the war.

Dr. O. K. Sprengel, surgeon-in-chief of the public hospital at Braunschweig and president of the German Surgical Association, has died from septic infection, professionally acquired, aged sixty-two years.

Dr. William J. Mayo and Dr. Charles H. Mayo, of Rochester, Minn., the distinguished surgeons, have decided to establish a $1,000,000 foundation for medical research and to place the foundation, under certain restrictions, in the hands of the University of Minnesota board of regents. It is planned that interest from the fund be used in research work at Rochester, open to graduate university medical students and leading to an additional degree granted by the university.

Middlebury College has received for its botanical collection from Miss Annie Lorenz, of Hartford, Conn., a nearly complete set of the Hepatics of Vermont.

We learn from the *British Medical Journal* that the statutory annual general meeting of the British Medical Association will be held this year, and also a meeting of the representative body, but at its meeting on January 27 the council decided that it would not be desirable, owing to the conditions brought about by the war, to hold the usual full annual meeting, with its scientific sections and social arrangements. A very large number of members of the association are directly occupied in work with the army in the field, or with the new armies that are being prepared, or in treating the wounded, while others not so engaged find the calls upon their time and energy, due to the withdrawal of so many medical men from ordinary practise, altogether unusual. Moreover, the annual meeting was to have been held this year in Cambridge, but the special circumstances of a university town deprived of many of its teachers and students by the war, and heavily committed to assist the Belgian universities, whose work has been suspended in their own country, make it impossible for Cambridge to maintain its invitation for this year.

The *Journal* of the American Medical Association states that medical students from the University of Toronto will largely compose the staff of the Clearing Hospital which will accompany the Second Canadian Contingent to France. Between forty and fifty fifth-year medical students will be taken following a request for volunteers. They will be given credit for their year on enlisting. The organization of the unit is in charge of Dr. George S. Rennie, Hamilton, Ont. When it arrives in France it will be in charge of Dr. Wallace A. Scott, Toronto, who went with the first contingent. Accompanying it will be Dr. George

S. Strathy and Dr. L. Bruce Robertson, Toronto, and Drs. Foster and James E. Davey, Hamilton. Dr. H. B. Yates, Montreal, is to be second in command to Dean Herbert S. Birkett of the medical faculty of McGill University and of the McGill University General Hospital, which is to go to France. The other officers who are to be appointed to the various ranks are: Drs. John M. Elder, John McCrae, J. George Adami, W. Henry P. Hill, Edward W. Archibald, A. Howard Pirie, L. J. Rhea, William G. Turner, C. P. Howard, Herbert M. Little, William B. Howell, Colin K. Russel, John W. Hutchinson, John C. Meakins, William W. Francis, J. A. MacMillan, R. H. M. Malone, Laurie H. McKim, and Mr. David Law, all of Montreal.

THAT Baltimore is gambling with the health of the people and the commerce of the port against the probability of an epidemic of the bubonic plague and that preventive measures ought to be taken to prevent a development of the plague here was stated by Dr. William C. Rucker, Washington, D. C., of the U. S. Public Health Service, in an address before the Public Health Conference, recently held in Baltimore, which is quoted in the *Journal* of the American Medical Association. He made it plain that every municipality that failed to take preventive measures is likely to find itself in the position of New Orleans, where the government, state and city authorities were spending hundreds of thousands of dollars to wipe out the bubonic plague, which might have been prevented, had there been a rodent survey of the city. The federal government has been willing to cooperate with the city authorities of Baltimore in making a rodent survey, but the city has refused to appropriate any money for such a purpose, although Health Commissioner Gorter has asked for such an appropriation.

NEW exhibits in the department of vertebrate paleontology of the American Museum of Natural History have recently been opened to the public. The first of these is a skeleton of *Scelidotherium,* which is a part of the Cope Pampean collection secured through the generosity of the late Morris K. Jesup, former president of the museum. This animal belongs to the sloth family and is interesting anatomically in its approach to the anteaters. Two nearly perfect skulls of horned dinosaurs have been added to the reptile collection. These are a part of the collection made by the museum expedition to the Red Deer River, Alberta, in 1913. The skeleton of the giant carnivorous dinosaur, *Tyrannosaurus,* is being mounted in the Pleistocene hall, and the new duck-billed dinosaur, *Corythosaurus,* in the dinosaur hall.

UNIVERSITY AND EDUCATIONAL NEWS

GIFTS of $25,000 to Yale University were announced at a meeting of the Yale Corporation held on February 15. Mrs. Charles W. Goodyear and Anson Conger Goodyear, of Buffalo, N. Y., have given $15,000 for the establishment of the Charles W. Goodyear fund in the Forestry School. The income of $10,000 from John B. Thomas, of New York, is to be used for providing for lectures by men of distinction on "The Real Purpose of the College Course," and kindred topics. These lectures are planned primarily for the academic freshmen.

THE new science building at Goshen College which is in process of construction will be dedicated on May 27. The principal address will be delivered by Dr. Eugene Davenport, dean of the college of agriculture and director of experimental station of the University of Illinois. This event will also mark the formal opening of the new departments of agriculture and domestic science at Goshen College.

THE University of Oregon has just completed a new psychological laboratory for both practise and research work. It consists of a suite of nine rooms, in addition to the lecture room, all of which are equipped with power circuits, gas, compressed air and an intercommunicating system of wires and speaking tubes.

AT Yale University, Lorande Loss Woodruff, Ph.D. (Columbia), assistant professor in the Sheffield Scientific School, has been elected professor of biology in Yale College.

In the University of London, Dr. Edward Barclay-Smith, of Cambridge, succeeds Professor Waterston in the chair of anatomy at King's College, and Dr. E. P. Cathcart, of Glasgow, succeeds Professor Leonard Hill in the chair of physiology at London Hospital Medical College.

DISCUSSION AND CORRESPONDENCE

EFFECT OF CYANIDE OF POTASSIUM ON TREES

To the Editor of Science: My attention has been attracted to an article in your columns by Professor H. A. Surface relative to the use of cyanide of potassium for eliminating insect attacks on trees. While I have not investigated the claim of the firm at Allentown, Pennsylvania, referred to in his article, and know nothing about their process, however, from my own results with cyanide of potassium, especially on elms and black locusts, I am convinced it is a valuable remedy.

The article above referred to gives the general impression that cyanide of potassium is the cause of tree death as well as various staining effects found in the bark, cambium, etc. My opinion is that the staining comes from the reaction between the tannic acid found in all trees and the iron found in this so-called "tree food" in the form of iron sulphate. It is well known that when solutions of tannic acid are brought into contact with iron or any iron salt, dark colored compounds resembling ink are formed. These are very permanent dyes and no doubt account for the dark color observed.

The cyanide of potassium as I have used it for years in eliminating borers from various trees has never caused any staining, nor have I ever known of its killing or in any way injuring a tree. I have been using it and prescribing it for the use of others for about twelve years in connection with my forestry work, and we have saved the lives of thousands of trees by means of it.

Large groves of thrifty elms and black locusts in Kansas and other parts of the west have been completely rescued from the attacks of boring and girdling insects by means of cyanide of potassium, and this article is the first intimation I have ever had to the effect that it is deleterious to tree growth. I am strongly inclined to feel that the blame is not properly placed and that a highly useful chemical for insect eradication is being condemned because of damages produced by other substances.

C. H. Shattuck
University of Idaho

GOSSYPOL—A TOXIC SUBSTANCE IN COTTONSEED. A PRELIMINARY NOTE

We have separated from cottonseed kernels a substance which appears to be identical with the substance which Marchlewski[1] separated from crude cottonseed oil and called gossypol.

We have administered in various ways, to rabbits, gossypol as prepared by us and have found it toxic in every case.

We have found as did Marchlewski that gossypol is quickly oxidized in an alcoholic solution of sodium hydroxide.

In a previous paper from this station[2] it was stated that "(alcoholic) alkaline treatment, very greatly diminishes if it does not entirely remove the toxic properties of the (cottonseed) meal," and it was suggested that the beneficial effect "may be due to hydrolysis or to the formation of a sodium salt or to some other change not yet determined definitely."

We now offer as an explanation that gossypol is a toxic substance and that its oxidation by an alcoholic alkali renders it nontoxic and thus diminishes if it does not entirely remove the toxic properties of cottonseed meal.

W. A. Withers,
F. E. Carruth

N. C. Agricultural Experiment Station,
Raleigh, N. C.,
December 31, 1914

SCIENTIFIC BOOKS

Bausteine zu einer Biologischen Weltanschauung. Von Jakob, Baron von Uexküll. München, F. Bruckmann A.-G. 1913.

[1] *J. für Prakt. Chem.* (1899), 60, p. 80.

[2] Withers and Ray, Science (1912), 36, p. 31.

Von Uexküll sketches and advocates a vitalistic "Weltanschauung" in eighteen popularized essays, collected for convenience into four larger groups, the whole, sponsored by Felix Gross, and dedicated to Stewart Houston Chamberlain. "Die Neuen Probleme" is introductory; "Der Neue Standpunkt" includes discussions of the invisible in nature, the "Merkwelt," and the problem of the animal mind; "Das Neue Weltbild" reproduces the tropical aquarium in a series of splendid word-pictures, and contains two essays devoted to the nature of life and five to the construction of a biological "Weltbild"; and finally, under the heading "Spezielle Fragen" we find ideas on morphogenesis, Mendelism, the origin of space, and a discussion of Pawlow's work in which for the first time in the reviewer's experience trypsin is met with playing the rôle of the "Hauptsprengstoff für die schwer verdaulichen Fette"! (p. 298).

Inasmuch as the arguments on which von Uexküll bases his vitalistic teachings have been discussed in an earlier review[1] and the present work contains nothing new in this respect, we may pass these over without further ado. There are three matters, however, which seem to deserve fuller mention; the first has to do with the general purposes of the book, the second, with the temperamental backgrounds of vitalism, whereas thirdly, we must consider a method proposed for application in the field of animal behavior.

To begin with, then, von Uexküll does not aim his guns primarily at the body of trained unbelievers, but, profiting by the experience of the Darwinian period of open debate, attempts to recapture for vitalism the public opinion taken in the earlier period by mechanistic assault. Such victories are theoretically quite beside the mark, but no one can look into the history of things without forming the impression that public opinion played an important part in the advance of mechanistic doctrine.

For the execution of this turning movement von Uexküll appears well equipped. He is afire with enthusiasm, gifted with a pretty wit, and is master of a literary technic the like of which has not been seen in biological circles since the days of the great Darwinian apologists. Furthermore, temperamental qualifications of another sort do special service in the hands of our reformer, and this brings us to our second point.

As some men under the strains of life are driven to church, so others, impressed with the difficulties of biology, take to vitalism. The impelling embarrassments are partly objective and well known to all; others, however, are individual, and of these von Uexküll carries a heavy load. One who asserts, "Die Amöben bleiben zeitlebens ein strukturloses Protoplasmahäufchen" (p. 210) and who claims, "In ganz frühen Stadien . . . besitzt der Keim keine Struktur" (p. 270), must be constituted blind to some of the best things in modern research.

In addition to these and numerous other specific subjective results, our author also sees in the lay mind many dire effects of current teachings. The world instructed by mechanical philosophers has lost the joy of life—"der Sternenhimmel ist den meisten Menschen zu einer greulichen verworrenen Rechenmaschine geworden, die ihnen einfach ekelhaft ist" (p. 259); men spend their days in senseless enumeration; believe that all the invisibles in nature are gases; accept a chemical morality but not its mirrored image; and, by the gradual working inward of their algebraized symbolism, are ailing and dying at the heart.

How much of this tragedy is true to life and how much a romantic adventure, is in the light of recent events not so easy to determine. It is hard, however, to consider all this a necessary consequence of mechanism, since Berkeley implied long ago that thoroughgoing mechanism and idealism may dwell at peace in the same mind. We are disposed to regard such lignifications of the heart and intellect, supposing them for the moment to have some objective reality, not as the inevitable results of a mechanism free from exaggeration, pretension and carelessness, but rather as the products of temperamental reactions to

[1] "Umwelt und Innenwelt der Tiere," SCIENCE, N. S., Vol. XXXI., pp. 303–305.

mechanism such as it unfortunately often is. All of which is suggestive not only to those who wonder why Germany, of all places, should prove a relatively favorable soil for modern metabiology, but to those also who ask whether the vitalistic-mechanistic debate can be closed.

Quite apart from these matters, von Uexküll's treatment of the environment, and of the relations of the organism thereto, has distinctly practical interest for the experimentalist. For Driesch the environment does not exist. Neither index of the two volumes on the "Science and Philosophy of the Organism" contains the word, nor is any discussion of the abode of life to be met with anywhere in the seven hundred pages of dreary text. Von Uexküll, on the contrary, is all aglow for the environment and its significance in the interpretation of life. Nor have these differences been without importance for the two authors under comparison; Driesch's reorganization of things biological has driven him out of the very field which should have proved more interesting than ever before; von Uexküll is continuing concrete observations and experiment and is pointing the way to further investigation with commendable fervor.

According to our writer, the environment of a living thing acquires special biological significance for us only when we discover and analyze those elements that actually act upon and with the organism in the normal give and take of daily existence. Such elements constitute the "Wirkungswelt." Further analysis differentiates out of the "Wirkungswelt" a "Merkwelt" which in the case of human beings, and perhaps wherever else it occurs, is specific for each individual.

These terms are practically self-explanatory. Air, for instance, is distinctly in our "Wirkungswelt," but may enter the "Merkwelt" under special circumstances. Now von Uexküll takes the position that students of behavior should limit themselves to a discovery by experiment of markworlds, and leave psychological considerations alone; brains and the objects of the external world can be experimented with, but of psychoses we can know one set only. The much exploited wonder-horses of Germany, the trained apes that open bolted doors, ring bells and order dinner, are monstrosities that have been forced to respond to the human order and not to normal constituents of either the horse- or monkey-world. Whether they have come to make these responses by trial and error, imitation or a system of rewards and punishments, is interesting only as a contribution to the art of unnatural history.

How the psychological difficulty is to be outflanked by this manœuver is not clear. The scallop's eye forms a retinal image like our own, yet the scallop "sees" only movements. To the specific forms, colors, sizes and the thousand other traits by which we distinguish one moving object from another this animal is blind. For the scallop a starfish, for us without taste or smell, has a pronounced odor indistinguishable from other chemical effects. Three marks in the following definite order (*time-scheme* as opposed to *space-scheme*) constitute a starfish in the scallop's "Merkwelt": movement, a general chemical mark, and a tactile stimulus. Given these in their orderly connection and the starfish is—"*wargenommen*"—that is, *perceived, observed, felt, taken care of, attended to,* or *availed of,* by the scallop. Clearly, until von Uexküll furnishes us with a system of notation by which the results of his experiments can be described without using words that suggest to every one the very thing upon which he has turned his back, discoveries concerning the markworld of the scallop are not likely to free us from the difficulties of an unanswerable question.

This does not mean that the method is inapplicable to cases in which the psychological question is respectable. On the contrary, James, in his essay "On a Certain Blindness in Human Beings," placed emphasis on the same spot fifteen years ago. In comparative psychology, and especially in experimental studies on human behavior, on the practise of education, and on the art of right living, numerous applications suggest themselves. If students adequately trained in the methods of science will seriously take up the experimental

analysis of normal markworlds, we may expect significant results in a field which needs them perhaps more than any other among the biological substations.

OTTO GLASER

UNIVERSITY OF MICHIGAN

SCIENTIFIC JOURNALS AND ARTICLES

THE closing (October) number of Volume 15 of the *Transactions of the American Mathematical Society* contains the following papers:

R. A. Johnson: "The conic as a space element."

G. A. Bliss: "The Weierstrass *E*-function for problems of the calculus of variations in space."

H. H. Mitchell: "The subgroups of the quaternary abelian linear group."

L. P. Eisenhart: "Transformations of conjugate systems with equal point invariants."

F. B. Wiley: "Proof of the finiteness of the modular covariants of a system of binary forms and cogredient points."

Dunham Jackson: "On the degree of convergence of Sturm-Liouville series."

C. E. Love: "Singular integral equations of the Volterra type."

G. C. Evans: "On the reduction of integro-differential equations."

L. E. Dickson: "Invariants in the theory of numbers."

Also addenda and errata of volumes 11 and 14 and general index of volumes 11–15.

THE November number (Vol. 21, No. 2) of the *Bulletin of the American Mathematical Society* contains: Report of the twenty-first summer meeting of the Society, by F. N. Cole; "Infinite regions in geometry," by E. B. Wilson; "Famous problems of geometry" (review of Hobson's Squaring the Circle, A History of the Problem), by R. C. Archibald; Shorter notices: Smith and Gale's New Analytic Geometry, by E. R. Smith; Marsh's Technical Trigonometry, by F. M. Morgan; Fite's College Algebra, by J. E. Rowe; Mitzscherling's Problem der Kreisteilung, by R. D. Carmichael; Kommerell's Allgemeine Theorie der Raumkurven und Flächen, by R. C. Archibald; Neumann's Fragen der höheren Potentialtheorie, by T. H. Gronwall; Kaye and Laby's Physical and Chemical Constants, by H. B. Phillips; "Notes"; and "New Publications."

THE December number of the *Bulletin* contains: "On a generalization of a theorem of Dini on sequences of continuous functions," by T. H. Hildebrandt; "Note on removable singularities," by W. E. Milne; "Concerning a certain totally discontinuous function," by K. P. Williams; "Proof of the convergence of Poisson's integral for non-absolutely integrable functions," by W. W. Küstermann; "The Napier tercentenary celebration," by D. E. Smith; "An appeal to producing mathematicians," by George Paaswell; Shorter notices: Zeuthen's Mathematik im Altertum und Mittelalter, by D. E. Smith; Minkowski's Geometrie der Zahlen, by L. E. Dickson; Elliott's Algebra of Quantics, by D. D. Leib; Fabry's Problèmes d'Analyse mathématique, by E. W. Ponzer; Demartres' Cours de Géométrie infinitésimale, by E. W. Ponzer; Engelhardt's Probleme im Schlusswort des Lies'chen Geometrie der Berührungstransformationen, by O. E. Glenn; Whiteford's Trisection of an Angle, by E. B. Lytle; Collins' Practical Algebra, by E. B. Lytle; Van Tuyl's Complete Business Arithmetic, by D. E. Smith; Martin's Text-book of Mechanics, by F. L. Griffin; Ott's Angewandte Mathematik an den Deutschen mittleren Fachschulen der Maschinenindustrie, by E. W. Ponzer; Jacoby's Astronomy, by K. P. Williams; "Notes"; and "New Publications."

THE January number of the *Bulletin* contains: Report of the October meeting of the Society, by F. N. Cole; Report of the twenty-sixth meeting of the San Francisco Section, by Thomas Buck; "Modular invariant processes," by O. E. Glenn; "Invariants, seminvariants, and covariants of the ternary and quaternary quadratic form modulo 2," by L. E. Dickson; "The converse of the Heine-Borel theorem in a Riesz domain," by E. W. Chittenden; "Complete existential theory of Sheffer's postulates for Boolean algebras," by L. L. Dines; "On the characteristics of the principal manuals of elementary geometry

published in Italy in the course of the last fifty years," by Mario Vecchi; "Mathematical methods in physics" (review of Volterra's Sur quelques Progrès récents de la Physique mathématique, Drei Vorlesungen über neuere Fortschritte der mathematischen Physik, and Leçons sur l'Intégration des Equations aux Dérivées partielles), by J. B. Shaw; Shorter notices: Berkeley's Mysticism in Mathematics, by C. J. Keyser; Aubert and Papelier's Exercices de Géométrie analytique, by F. M. Morgan; Hardy's Orders of Infinity, by W. A. Hurwitz; Smith and Karpinski's Hindu-Arabic Numerals, by J. V. McKelvey; Dalwigk's Darstellende Geometrie, by J. V. McKelvey; Schmid's Darstellende Geometrie, by Virgil Snyder; Auerbach's Graphische Darstellung, by Virgil Snyder; Meyer's Differential- und Integralrechnung, by Virgil Snyder; Note on "The discovery of inversion," by Arnold Emch; Correction; "Notes"; and "New Publications."

SPECIAL ARTICLES

THE IDENTITY OF HELIOTROPISM IN ANIMALS AND PLANTS. SECOND NOTE[1]

Paul Bert had shown in 1869 that if the small fresh-water crustacean *Daphnia* is exposed to a solar spectrum it goes towards the source of light in all parts of the visible spectrum, but most rapidly in the yellow or green.

Il fut facile de remarquer qu'elles accouraient beaucoup plus rapidement au jaune ou au vert qu'à toute autre couleur.[2]

The fact of the predominance of the heliotropic efficiency of the yellowish-green in these and some other animals led the ophthalmologist Hess to two assumptions, first that they are totally color-blind (since the yellowish-green part of the spectrum is the brightest for the eye of the totally color-blind human) and second, that the sensation of brightness is the cause of the heliotropic reaction of animals. It is obvious that these conclusions go beyond the facts, since we have no proof for the assumption that the heliotropic effects of light in lower animals are accompanied or determined by any sensations of brightness and since totally color-blind humans do not show any positive heliotropism. In consequence of his two arbitrary assumptions, Hess is forced to the further conclusion that the heliotropic reactions in animals and plants can not be identical, since he does not seem ready to discuss the light and color sensations of plants, and he tries to support this conclusion by the statement that heliotropic plants and animals are sensitive to different parts of the spectrum, all animals to the yellowish-green, all plants to the blue. We have already pointed out in our previous note[3] that this latter statement is not correct, since we were able to show that for the positively heliotropic animal, *Eudendrium*, the most efficient part of the spectrum lies in a carbon arc spectrum in the blue near the region $\lambda = 474\ \mu\mu$, where it also lies, according to Blaauw, for the seedlings of oats.

It seemed of interest to find out whether for different motile unicellular organisms which contain chlorophyll and which are on the border line between plants and animals the most efficient part of the spectrum for the production of heliotropic reaction lies always in the same region. We investigated the reactions of *Chlamydomonas pisiformis* and of *Euglena viridis* in a carbon arc spectrum. The investigation of the behavior of these organisms in the spectrum showed a marked difference. *Euglena* gather in the blue part of the spectrum, usually in the region between $\lambda = 438$ and $\lambda = 510\ \mu\mu$. The densest gathering was generally in the region of $\lambda = 475\ \mu\mu$. In the case of *Chlamydomonas* the gathering always went much farther towards the yellow, usually having its limit in the region of about $\lambda = 560$ or $\lambda = 570\ \mu\mu$. It was in most cases not easy, however, to ascertain the region of maximal gathering, though in many cases it seemed to be about $\lambda = 520\ \mu\mu$. The most remarkable difference between the behavior of the two forms in the spectrum was therefore the fact that *Chlamydomonas* was sensitive to longer waves than *Euglena*.

It soon became obvious that this method of procedure does not permit the decision of the

[1] Loeb and Wasteneys, *Proc. Nat. Acad. Sc.*, I., p. 44, 1915.

[2] Paul Bert, *Arch. de Physiol.*, II., p. 547, 1869.

[3] Loeb and Wasteneys, *Proc. Nat. Acad. Sc.*, I., p. 44, 1915.

question of the relative efficiency of the different parts of the spectrum for both forms with sufficient accuracy. We selected, therefore, a different method which allowed us to compare the relative efficiency of two narrow parts of the spectrum. A carbon arc spectrum, 23 cm. wide, was thrown on a black screen *SS* (see

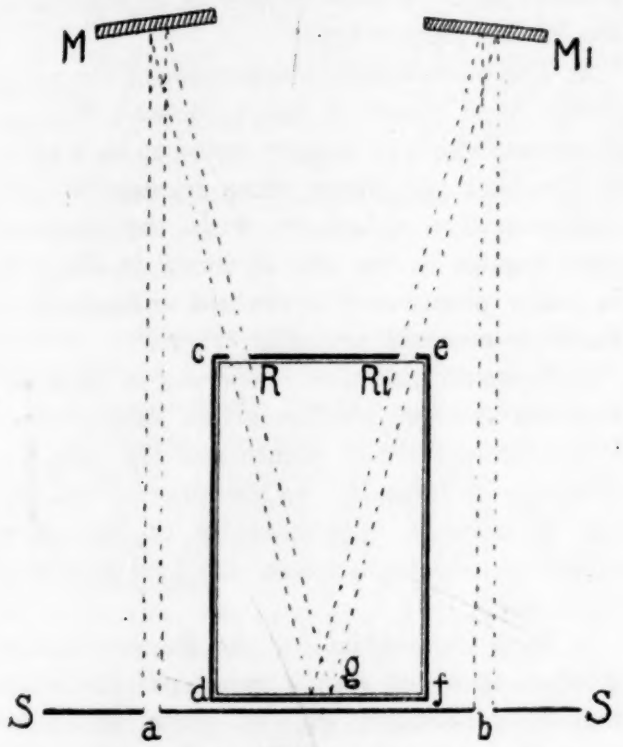

FIG. 1.

Fig. 1) with two slits *a* and *b* in the two different parts of the spectrum which were to be compared in regard to their heliotropic efficiency. The two beams of light passing through the slits are reflected by the two mirrors M and M_1 into the square glass trough in such a way as to strike the same region *g* of the back wall of the trough. The glass trough is surrounded by black paper except at R and R_1, where the two beams of light enter from the mirrors. Before the experiment begins, all the organisms are collected in the region *g* by a special arrangement which need not be described here. As soon as the spectrum is turned on, these organisms are simultaneously exposed to two different beams of light which come from the two mirrors M and M_1. When one type of light, *e. g.*, that from M, is much more efficient than the other coming from M_1, practically all the organisms are oriented by the light from M and move toward this mirror, collecting in the region R. When the relative efficiency of the two types of light is almost equal the organisms move in almost equal numbers to R and R_1. By using as a standard of comparison the same region of the spectrum and successively altering the position of the other slit in the spectrum we were able to ascertain with accuracy the relative efficiency of the different parts of the spectrum for the two forms of organisms. When the two parts of the spectrum which are to be compared are very close to each other it is necessary to deflect the beams with the aid of deflecting prisms, before they reach the two mirrors. It turned out in these experiments that for *Euglena* the region of maximum efficiency was in the blue between $\lambda = 462$ and $\lambda = 492\ \mu\mu$; while for *Chlamydomonas* it was in the green or greenish-yellow between $\lambda = 529$ and $\lambda = 539\ \mu\mu$. In other words, *Euglena* behaved like the seedlings of oats and like *Eudendrium*, both of which had their maximum of efficiency in the blue (in the carbon arc spectrum); while *Chlamydomonas* behaved like *Daphnia*. We may remark incidentally that earlier experiments by Loeb and Maxwell[4] on *Chlamydomonas* had led these authors to the same conclusion.

From the viewpoint of Hess, which seems to have met the approval of several German physiologists, we should be forced to conclude that the unicellular green organism, *Chlamydomonas*, has sensations of brightness, that it is totally color-blind and that it is not heliotropic; while the unicellular green organism, *Euglena*, has no sensations of brightness, is not color-blind and is heliotropic. The confusion created by this mode of reasoning is increased if we consider that *Chlamydomonas* is usually claimed by the botanist and *Euglena* by the zoologist.

We are inclined to put a different interpretation upon our observations, namely, that heliotropic reactions may be determined by two different types of photosensitive substances or by the same type of photosensitive substance in two modifications. One of these types of substances or modifications has its maximum

[4] *Univ. Calif. Publ.*, Physiology, III., p. 195, 1910.

of sensitiveness in the blue (in the neighborhood of $\lambda = 477\ \mu\mu$), the other in the yellowish-green (in the region of $\lambda = 534\ \mu\mu$). The latter type is found in *Chlamydomonas, Daphnia,* the larvæ of barnacles and other organisms; the former type exists in *Euglena, Eudendrium,* the seedlings of oats and others.

It seems of interest to call attention to the fact that according to the measurements of Trendelenburg the visual purple in the eye of the rabbit is bleached most rapidly by light of the wave-length $\lambda = 536\ \mu\mu$. As Kuehne had already shown, visual purple is not affected by red light, and only feebly by yellow light. The relative efficiency of different parts of the spectrum for the heliotropic reactions of *Chlamydomonas* coincides, therefore, approximately with the relative bleaching power of rays of different wave-lengths for visual purple. This makes it almost appear as if in the one group of organisms, namely, those which behave like *Daphnia* or *Chlamydomonas,* the heliotropic reactions were determined by a substance or by substances which behave in regard to photosensitiveness like visual purple; and which may possibly be identical with visual purple.

This assumption allows us to explain the heliotropic reactions of lower organisms without arbitrarily ascribing to them sensations of brightness the existence of which can in their case not be proved. And, furthermore, when the heliotropic effect of rays of different wave-lengths upon lower organisms is found to run parallel to their effect upon the bleaching of visual purple (as it does in *Daphnia* and *Chlamydomonas*) it seems more rational and promising to conclude that the heliotropism in these cases is caused by a substance or substances which behave photochemically like visual purple than that these lower organisms suffer from total color-blindness. We have already shown in our first note that the theory of heliotropic orientation is independent of the relative efficiency of different wave-lengths.

We may summarize the results of our experiments in the following way:

1. The validity of the Bunsen-Roscoe law for the heliotropic reactions of certain (and possibly all) plants and animals suggests that these reactions are due to a chemical action of the light.

2. There seem to exist two types of heliotropic substances, one with a maximum of sensitiveness (or absorption) in the yellowish-green (near $\lambda = 534\ \mu\mu$) and the second with a maximum of sensitiveness in the blue (near $\lambda = 477\ \mu\mu$). Visual purple is a representative of the former type.

3. The photosensitive substance of the visual purple type occurs in the protozoan *Chlamydomonas,* which is usually stated to be a plant, in *Daphnia* and many other organisms. The photosensitive substance with the maximal sensitiveness in the blue is found in *Euglena,* in many plants and in certain animals, *e. g., Eudendrium* and probably others.[5]

4. It would, therefore, be wrong to state that the one type of photosensitive substances is found exclusively in plants and the other exclusively in animals. As a matter of fact they are distributed independently of the systematic boundaries between the two groups of organisms.

5. It is immaterial for the theory of heliotropism to which of the two types the photosensitive substance in any given heliotropic organism belongs.

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Hardolph Wasteneys

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American Association for the Advancement of Science

Section M, Agriculture

The first meeting of Section M, Agriculture, of the American Association for the Advancement of Science, was held in the Engineering Building of the University of Pennsylvania, Philadelphia, December 30, 1914.

The inauguration of the new section was particularly auspicious, and the large attendance was encouraging as indicating wide interest. Dr. Charles W. Eliot, president of the Association, presided at the opening of the meeting, and in a brief address called attention to the great importance of the agricultural industry, and expressed

[5] This seems to be indicated by the work of Parker and his pupils.

his gratification at the provision of the section. It is high time, he said, that we began to attend to the building up of American agriculture, and to recognize its basis in science. He expressed his special interest in the teaching of agriculture on account of the opportunity it offered for furthering the teaching of natural sciences in the schools. This, he declared, is the great reform needed in American education. The popular interest now aroused in agricultural teaching offers an entering wedge in this direction, and gives hope for the accomplishment of even greater reforms. Country-life development Dr. Eliot pronounced "one of the greatest humanitarian movements of this age." Our race can not endure urban life and the factory system, he said; the ill effects of it have already been seen. "Hence anything that leads men into the country where they may lead a wholesome existence is contributing to a necessarily humanitarian movement."

These remarks furnished an appropriate introduction to the vice-presidential address of Professor L. H. Bailey, on "The Place of Research and of Publicity in the Forthcoming Country Life Development." The address was essentially a plea for the principles of democracy, approached from the standpoint of the public service institutions for agriculture, and especially the new national work for agricultural extension.

The other feature of the meeting was a symposium devoted to "The Field of Rural Economics." This was participated in by four speakers, who dealt with several phases of the general subject. In opening the subject, Hon. Carl Vrooman, Assistant Secretary of Agriculture, discussed "Rural Economics from the Standpoint of the Farmer." He corrected some of the false impressions as to the advantages of high acre yields, pointing out that the plain business question is not how much the farmer could produce if he had no regard for the cost, but how much he can afford to produce under present American conditions. He showed by statistics that the largest crops do not necessarily mean the largest net income to the farmer, and that in years of relatively small production he often realizes quite as much from his crops as in years of maximum yield.

Secretary Vrooman laid much emphasis on the importance of the problems of distribution and marketing, enforcing his remarks by illustrations from his own experience as a farmer. While admitting the necessity for middlemen and other intermediaries, he protested against any allied interest taking more than a legitimate profit from the farmer. He declared that the average farmer is only making wages: he is not making a profit over his wages and the interest on his investment. Until the problems of agricultural economics are solved there is little encouragement for him in attempting to raise larger crops. "Economic justice to the farmer and producing classes," he said, "must be the basis of the higher civilization which we picture."

In discussing "Credit and Agriculture," Professor G. N. Lauman, of Cornell University, maintained that in this country credit has not been generally available to the farmer except at a considerable premium, and that in order to develop American agriculture and rural life it must be made feasible for a man to be successively a farm laborer, a farm renter and a farm owner. Short-time credit was held to be a distinctly local matter. The community should rally all its capital to develop itself, and should organize to furnish the basis for a closer association between itself and existing banking and credit facilities. The great social and ethical gains from the small credit unions of Europe was explained, especially in helping the small farmer.

In order to bring outside capital into agriculture it is necessary to meet the demands which such capital makes. Credit, it was declared, "has no better basis than farm values made fluid." Rightly developed, bonds based on land mortgages have no superiors in the investment field. These, it was explained, should be of small enough denominations to be accessible to all classes and available on all exchanges. But the prevalent machinery for this is too expensive a burden on agriculture.

Professor Lauman did not advocate leaving the problem to either the government or to private capital for solution, but urged organization. "If agriculture organized to make it possible to demand the lowest rates of interest the market affords, can not live and develop, not even state aid will prevent its ultimate decay."

In a paper on "Marketing and Distribution Problems," Mr. C. J. Brand, of the Department of Agriculture, presented the needs of the farmer in the way of assistance in establishing a market system which will return to him the true value of the various crops he produces, minus reasonable charges for handling, transportation and the legitimate profits of middlemen. He outlined the various lines of study which are being pursued by the Office of Markets and Rural Organization. These are concerned, in part, with a study of conditions

as they actually exist over the country in the handling and marketing of cotton, grain, live stock, meat and meat products, fruits, vegetables, dairy and other products, followed through from the producer to the consumer, with statistical studies of supply and demand. Market grades and standards are also being investigated, with the object of effecting greater uniformity; and transportation and storage, as to methods, the adequacy of facilities, and the relation of warehousing, refrigeration, etc., to prices and to stabilizing supplies.

Market surveys are being made with a view to collecting facts and developing methods for bringing useful information in regard to prices and supplies promptly to producers and consumers. The practise in vogue in marketing and distribution in large cities is the subject of a special inquiry, to make comparisons and arrive at the most advantageous plans. Direct dealing through marketing by parcel post and by express is being studied, not only as to practicability and advantages, but as to systems for bringing producers and consumers into contact and establishing their business relationships. Cooperative buying and selling naturally attracts considerable attention, with inquiry into the methods and success of organizations, and the supplying of assistance in organization, systems of accounting, auditing, etc.

The partial enumeration of these lines of effort illustrated some of the problems in marketing. From a consideration of cotton handling and marketing, Mr. Brand showed that the acute problems are not confined to perishable crops. The cantaloupe trade was cited to show an overdevelopment of the industry, due to ignorance as to the development of competitive areas, which in 1914 resulted in disaster to the producers and to the large distributors. As usual, the slump in prices was not reflected in the retail trade, consumers paying practically as much as in a year of scarcity, while the surplus went to the dump. The conclusion is that "until we have a more complete system of information and a better adjustment of production to market requirements, this problem will continue to be with us."

Cooperation was not regarded as necessarily the panacea for all marketing troubles. Organization was favored, but alone it is not sufficient; it must be accompanied by skilful and intelligent management. To protect shippers from imposition and misrepresentation at large markets and terminals, a licensed inspection system was suggested, and illustrations of the use it could serve were cited.

"The Distinction Between Efficiency in Production and Efficiency in Bargaining" was well illustrated by Dr. T. N. Carver, of Harvard University. He explained that every legitimate business is made up of two parts, one of which may be called producing, including any handling of the material which renders it more usable or useful, and the other bargaining, *i. e.*, buying and selling, borrowing and lending. Many of the supposed economies of large-scale business turn out upon examination to be advantages in bargaining rather than economies in production. In most lines of business there is a certain size which gives the maximum efficiency in production, and also in bargaining. These do not necessarily coincide, but as a rule, the size which gives the maximum efficiency in bargaining is larger than that for production.

In agriculture the most efficient producing unit was said to be the one-family farm, provided with the best teams, tools and general equipment. This gives the highest average product, man for man. If the large farmer is able to command some special advantages in securing cheap labor, he may beat the small farmer in competition with him, but this is advantage in bargaining. His profit may be larger, in spite of the lower average productivity of the persons engaged. The foisting upon the rural districts of a large supply of cheap labor is designed to give the large farmer an advantage in purchasing his labor.

Again, it was pointed out that in buying his supplies and in selling his products, especially if they are perishable, the large farmer usually has an advantage. "The small farmer of the present day is the only large class which regularly buys its raw material at retail and sells its finished product at wholesale." This can be overcome by "collective bargaining" or cooperation, which may give the small farmer the same advantages which the large farmer enjoys; and the same is true in borrowing capital. Hence for the small farmer, who appears to be efficient in production, organization into larger units was urged, to overcome inefficiency in buying and selling.

Dean E. Davenport, of the University of Illinois, was elected vice-president and chairman of the section for the ensuing year, Dr. A. C. True, of the Office of Experiment Stations, was chosen member of the General Committee of the Association; Dr. W. A. Taylor, of the Bureau of Plant Industry, member of the council, and President Kenyon L. Butterfield, of Massachusetts, a member of the sectional committee (for five years).

E. W. Allen,
Secretary